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Public Private Partnerships, an investigation and comparison with traditional procurement contracts in Norwegian Road projects.

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Project Management

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PREFACE

This report is the result of the work with the project group's master thesis at the Norwegian university of science and technology in the spring of 2014. The thesis is written at the Faculty of social science and technology management and fills the subject TIØ4920. The master thesis is the finishing work in the international master degree of project management, and is weighted with 30 study points (ECTS). The project group consisted of Erlend Helmersen and Henrik André Pedersen.

The report is written in cooperation with the Norwegian public roads administration (NPRA). The intention of the thesis is to investigate and do a comparison of public private partnerships and traditional procurement in Norwegian road projects. The main content of the report is based on literature review, a questionnaire and interviews with key persons. The work is financed by the Norwegian public roads administration.

The project group would like to thank the supervisor from the institute, Tim Kristian Andreas Torvatn for the guidance with the work during the project. The project group would also like to thank the supervisor at the NPRA, Ivar Horvli for his patience, information and guidance. The project group would also like to thank Jenny Myrenget Sjøli, Bern Skram-Fuglset, Nils Inge Romarheim, Jan Egil Eilertsen and Mikal Øien at the NPRA for the information they have provided. The project would also like to thank the PPP companies who have willingly shared relevant information, and with that, contributed to the thesis.

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ABSTRACT

A new government gives room for new ideas and the implementation of these. In the case of public private partnerships, it is more that the government is brushing of the dust from something the same governing party (The Conservative party, Høyre) started the last time they had governing power in Norway. In 1998, they started three trial PPP projects in road infrastructure. This is some years ago, and with the rejuvenated focus on PPP, it would be wise to see how the three first projects faired compared to the more traditional way of organising the construction of roads in Norway.

A key characteristic of public-private partnerships is that the two tasks of building a facility and subsequently operating it are bundled and delegated to a single private contractor, while under traditional procurement, separate contractors are in charge of these two tasks. This thesis seeks to find what contracts and financing possibilities there are, as well have a look at what the different types offer. The aim is to find out whether it is possible to use the market even better in order to find a solution to build roads with a span longer than the finalisation of the road. By that, the meaning is taking the operation of the road into account.

In order to answer these challenges, the aim of this thesis seek to:

(1) Create an overview over contract details in the three existing Norwegian PPP projects and compare it to the traditional contract formulation regarding both construction and later operation of the road. The aim is to find a way to describe the governance and payment scheme for PPP compared to traditional contracts.
(2) Consider factors that influences the LCC in the PPP contract E39 Klett-Bårdshaug, and evaluate findings with traditional construction and operation contracts.
(3) If possible, find a conceptual estimate for the LCC at E39 Klett-Bårdshaug, compared to LCC for similar road elements (road in the day, bridge, and tunnel) from traditional road construction contracts regarding both construction and operation.

When looking at what elements in the PPP project E39 Klett-Bårdshaug that effect the LCC, several factors that can be hard to transfer to traditional contract forms is identified, including total enterprises such as the road development contract. The payment model and scheme is something you only get with a PPP project. The findings shows that it is reasonable to attribute many of the positive sides of PPP to the payment scheme, but also most of the negative sides. The road development contract tries to implement some of the positive sides, and the results of the test project in E6 Helgeland will show the output.

There are clear differences between the PPP contract used in Norway, and the examples being used as a deterrent against using it. The finance and payment profile in the Norwegian contract will not be affected in the same way by the financial crisis as in other countries. In other countries, the reduced traffic amount due to the crisis lead to the need for governmental support in order to keep the projects going. Some of these projects have changed to a payment scheme more similar to the Norwegian one, where the toll income goes to the Government, which in turn pays out the money from the toll stations and ads over the budget if the tolls does not cover the needed payment sum.

Getting relevant figures from the PPP projects turned out to be hard, the same when it came to similar traditional construction and maintenance projects. A report containing general maintenance and construction figures was acquired, which made it possible to do an estimate of what the maintenance costs of the PPP project would be if it were a traditional maintenance contract. The conceptual estimate show maintenance costs for the road according to NPRA standards. Through analysis of the traffic, an alternative way of measuring the traffic is also presented.

SAMMENDRAG

Med en ny regjering kommer det nye ideer og andre metoder for å gjennomføre disse ideene, slik som offentlig-privat samarbeid (OPS). For å presisere, er det heller at regjeringen pusser av støvet fra noe det samme Høyre startet sist gang de hadde regjeringsmakt i Norge. I 1998 vedtok de å startet de tre OPS-prøveprosjekter innen vei som vi kjenner i dag. Dette er noen år siden, og med fornyet fokus på OPS er det klokt å se hvordan de tre første prosjektene gjorde det i forhold til den mer tradisjonelle måten å organisere bygging av veier i Norge.

Et sentralt kjennetegn ved OPS er at oppgavene med å bygge et anlegg, og deretter drifte og vedlikeholde det, er samlet og delegert til en privat entreprenør, mens under tradisjonelle innkjøp vil prosjektet deles opp i separate kontrakter for byggefasen, drift og vedlikehold. Denne oppgaven søker å finne ut hvilke kontrakter og finansieringsmuligheter som finnes, samt ta en titt på hva de forskjellige typene har å tilby. Målet er å finne ut om det er mulig å bruke markedet enda bedre for å finne en løsning for å bygge veier med en lengre varighet på kontrakten enn bare frem til ferdigstillelse av byggingen. Tanken er da å ta driften og vedlikeholdet av veien med i betraktningen.

For å svare på disse utfordringene, er søker denne avhandlingen nå målet ved å:

(1) Lage en oversikt over kontraktsbestemmelser og detaljer i de tre eksisterende norske OPS-prosjektene, og sammenligne de med de mer tradisjonelle kontraktstypene for både bygging, vedlikehold og drift av veier. Målet er å finne en måte å beskrive styring og betalingsordningen for OPS sammenlignet med tradisjonelle kontrakter.
(2) Vurdere faktorer som påvirker livssykluskostnadene i OPS-kontrakten E39 Klett - Bårdshaug, og vurdere funnene opp mot tradisjonelle bygge og driftskontrakter.
(3) Hvis mulig, finne et konseptuelt estimat for livsløpskostnader på E39 Klett - Bårdshaug, sammenlignet med livsløpskostnader for lignende veielementer (veg i dagen, bro og tunnel) fra tradisjonelle veiutbyggingskontrakter og drift- og vedlikeholdskontrakter.

Når man ser på hvilke elementer i OPS-prosjektet E39 Klett - Bårdshaug som påvirker livsløpskostnader, er flere faktorer som kan være vanskelig å overføre til tradisjonelle entrepriseformer identifisert, herunder totale entrepriser som for eksempel veien utviklingskontrakten. Finansieringsmodellen er noe man bare får med et OPS-prosjekt. Våre resultater viser at det er rimelig å tilskrive mange av de positive sider ved OPS til finansieringsordningen, men også mesteparten av de negative sidene. Vegutviklingskontrakten forsøker å implementere noen av de positive sidene av OPS, og resultatet av testprosjektet på E6 Helgeland vil vise resultatet av dette.

Det er klare forskjeller mellom OPS-kontrakten som brukes i Norge, og eksemplene blir brukt for å avskrekke de som vil bruke OPS. Finansierings- og betalingsprofilen i den norske kontrakten vil ikke bli påvirket på samme måte av finanskrisen som i andre land. I andre land, resulterte redusert trafikkmengde på grunn av krisen til et behov for statlig støtte for å holde prosjektene i gang. Noen av disse prosjektene har byttet til en betalingsordning mer lik den norske, der bompenge inntektene går til staten, som igjen betaler ut pengene fra bomstasjonene og supplerer dette med bevilger over statsbudsjettet hvis bompengene ikke dekker nødvendige kontraktssum.

Å få relevante tall fra OPS-prosjektene viste seg å være vanskelig, det samme gjelder det å få relevante tall fra lignende tradisjonelle bygge og vedlikeholdsprosjekter. En rapport som inneholder generelle vedlikeholds -og bygge tall for tradisjonelle kontrakter er det gitt tilgang til, noe som gjorde det mulig å gjøre et anslag over hva vedlikeholdskostnadene for OPS-prosjektet ville være hvis det hadde vært en tradisjonell vedlikeholdskontrakt. Et konseptuelt estimat viser vedlikeholdskostnader for veien i henhold til Statens vegvesens standarder. Gjennom en analyse av trafikkmengde er en alternativ måte å måle trafikk og kostnadene til dette også presentert.

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ABBREVIATIONS

YDT:	Yearly Daily Average Traffic	DBFMO:	Design-Build-Finance-Maintain-Operate
PPP:	Public Private Partnership	TP:	Traditional Procurement
LCC:	Life Cycle Cost	WLC:	Whole Life Cost
		The NPRA:	The National Public Roads Administration

1 PROBLEM STATEMENT

It is clear that transport and communication costs is a considerable portion of a country's budget. In the national budget for 2014 (presented by the old government in October 2013), 45,2 billion NOK was allocated to transportation matters, which includes rail and road. Comparing these numbers to other matters, it is a significant number. For example is the total expenses for the Norwegian defence around 45 billion NOK, and education somewhere around 29 billion NOK.

The importance of having good infrastructure is important. Norway's closest neighbour, Sweden had in 2010 21289 km of highway, while Norway at the same time had 27427 kilometres highway. Taking into account that there are living almost twice as many people in Sweden compared to Norway, it is clear that road development must stand for a high proportion of the budget. The government also states that with the budget allocations for road building in 2013 (when finished), the total meters of four-lane highway will be doubled compared to 2005.

The new government early stated its extra commitment to expanding the development of infrastructure in transportation. This is illustrated by the fact that they in the revised budget for 2014 gives an extra 1,4 billion NOK to roads and railroad, mainly to maintenance costs of old roads and tunnels (Regjeringen, 2013b). This new political direction will increase the need for a method of organising projects in a way that reduces cost, and raises quality, and that can be unified with the idea behind PPP. With this in mind, putting more emphasis on doing a deep analysis of what is contributing to more efficient use of these money is important. This thesis seek to contribute to analyse the PPP today compared to traditional procurement contracts.

The new government has intent to establish a company that will be responsible for the building of new roads more efficiently. The building of new roads and railroad will be organised in public private partnerships (PPP) on a much larger scale than what has been the reality until now.

«There will be established a development company that will lift several road projects and follow through the building more efficient. /Det etableres et eget utbyggingsselskap som skal løfte flere veiprosjekter og gjennomføre utbygging mer effektivt..»(Regjeringen, 2013a)

«Start the work of catching up with the maintenance lag of infrastructure. /Starte arbeidet med å innhente vedlikeholdsetterslepet på infrastruktur.» (Regjeringen, 2013a)

«Organize larger road and railway developments as own projects where PPP is used as implementation strategy. / Organisere større vei- og jernbaneutbygginger som egne prosjekter der offentlig-privat samarbeid (OPS) brukes som gjennomføringsstrategi.» (Regjeringen, 2013a)

The government has also discussed using PPP as strategy for other construction projects, such as schools and other public. This project will not put any emphasis into that, because the project group found such projects to be successful in the Great Britain, but Norwegian experience on the area is more balanced in its praise.

During the election period in Norway the fall of 2013, there were made several contradicting statements about PPP. The Conservative Party (Høyre), which is one of the new governing parties, proclaimed that PPP in road projects would help reduce the construction time, and that the projects would be cheaper. The losing party, The Labour Party (Arbeiderpartiet) proclaimed that all experience with PPP from other countries has shown that PPP is not cheaper, but more expensive than traditional projects.

This project seeks to do a comparison between existing PPP projects and traditional procurement projects in an attempt to find out if there are any differences. Also finding out if there are differences between the Norwegian PPP contracts and the ones used in other countries and try to shed light on what the trout actually is when it comes to PPP, and if there are any experiences that one can learn from.

1.1 Finding and developing the problem statement

"The master thesis is meant to enable the students to develop deeper knowledge, understanding, capabilities and attitudes in the context of the field of study" (Chalmers, 2012), which in the project groups case is within project management. This is the purpose of the master thesis, and the aim is to find a problem that is suitable to solve in order to prove the capabilities.

"During the master thesis, the students should develop detailed knowledge about one particular area within the main profile area of the student(s)"(NTNU, 2014). As the main profile is industrial economics, with focus on public-private procurements, a process similar to a setting that can be faced by project managers must be included. A decision making process and a comparison between options must also be included. The final problem statement in this thesis suits the specialization course and gives suitable challenges in the right areas compared to the subjects chosen during the two years in the master degree.

The background for finding a thesis topic within the segment chosen was the specialization project written during the autumn semester of 2013. The specialization project gave us the opportunity to see what could be done about the specific theme that was chosen during the summer of 2013, which was supplier-buyer relationships in private operation of public services. At that time, the choice was to look at public procurement, and the challenges regarding increasing collaboration with the private, as more agencies that are public are being privatized. A few industries and business practices was investigated, and later a possible problem to research in the master thesis was uncovered. The aim of the project was to find out how business practice today look at the LCC of a project. The questions asked was whether the Norwegian regulations regarding public procurement could use LCC as criteria in tender competition. Finding out where it was in use today as well as searching to find which perceptions there were around the term LCC was also set as a goal. How LCC use today influences different businesses, how the Norwegian regulations creates room for the use of LCC and what the term really includes was the next step. As the project developed, a collaboration partner for the master thesis was found, in the NPRA. Because there already were questions at that time needing answers regarding road construction, because of the result in the recent elections and their vision on developing infrastructure, that was used as one of the businesses to investigate. In the project, there was presented many interesting findings regarding how money was spent on such projects in Norway. It is presented in the project that many road projects are chosen based on lowest initial cost, leading to the fact that many projects are not conducted with the best cost effective alternative. Especially regarding tunnels, which there are a lot of in Norway, the head of the NPRA, Terje Moe Gustavsen, stated that there was put too much emphasis on saving initial cost in favour of lowest possible LCC. Through that, as well as other comments from road authorities and other findings, it became clear that the planning of projects could be done even better; especially regarding on what basis a contract is selected.

As the specialization project developed, the NPRA southern division was asked regarding the possibility for writing a master thesis with them as case company. Erlend knew people from summer internships over three years, and had discussed the possibility with them at an earlier date. Later an answer was received from the NPRA central regional division, which covers Møre og Romsdal and the Trøndelag region of Norway. In November 2013, the initial meeting was held, and agreement was

reached regarding the wish to arrange the master thesis in collaboration with the NPRA. When discussing scope for the thesis, the project group had some thoughts of what could be a point of attack. The project group saw that the recent election result made room for a PPP project focus. The government clearly stated in their platform that a focus point for them was developing more roads with the PPP strategy. As all involved parts had this in mind, PPP was agreed upon being a very good theme. Before Christmas 2013, there was a mutual agreement to collaborate and doing a master thesis where the main theme was comparing a traditional procurement to a PPP. As it includes important parts of decision making for a project manager, also giving us the opportunity to compare two different strategies, it was also a focus point that was recommended by the supervisor at the university.

At that point, the theme of the thesis was established. In order to find a specific problem statement, a collaboration with both the supervisor and the NPRA was necessary. During a meeting with the NPRA, different points of attack was discussed, regarding data availability, possibility for publication of the thesis and what methodology best suited for the problem statement. Initial thoughts included comparing only two projects, with rather similar conditions. At the beginning, the aim was to compare two similar projects, E39 Klett-Bårdshaug and E6 Trondheim-Stjørdal, because there are rather small differences between them, except what contract strategy is used. Both routes include a variety of road in the day, bridges and tunnels, as well as they have not too big deviation in daily traffic volume. The climate conditions and geographical conditions are also very similar. NPRA agreed to this, and Ivar Horvli, one of the supervisors from the NPRA, thought that including all the PPP projects from Norway was a good development of the problem statement. This because it would enable the project to have a broader vision of the PPP projects already in operation, as well as being able to include possible challenges met in other projects in other parts of the country with other contractors. This was a good thought, because it enables the project to include a broader view of how PPP is working in practice. This is positive both in case of not being able to bring out needed data from the E39 project, as well as having better data comparison with three PPP projects as data. If challenges any were met, for example in not having good enough data, a utilization of the findings from the other projects could also be possible.

The NPRA state: “The project must ensure that the project get the deliveries that are agreed upon in the contract, within the time frame, with the correct quality and at the right price. Quality also includes the consideration of the internal and external environment. It is important to us that the project create the project in a manner that encourage the most cost effective solutions in the market the project are approaching.” (Byggherreseksjonen, 2012)

Road construction and infrastructure is an important part of the development of the society. Roads are very expensive, built with funding from public money. Thus, the demand for facilitating and building the road at the lowest possible cost, but still according to quality standards, are high. However, there has been arguments saying that there are possible to build even better roads than the specification from the NPRA demand(Sjøli, 2013). Norway is also a very widespread country with settlements deepest into the longest fjords, along the steepest creeks and on both sides of challenging mountains. Norwegians do as well live in remote areas and on islands far out in the ocean along the coastline, which again demands infrastructure bonding all these remote areas together. Keeping such widespread demography is stated by the government (moderinseringsdepartementet, 2004), and demands the NPRA to facilitate for it. One can neither forget that the nation also has big cities, with challenges regarding infrastructure and especially with many people moving to the biggest cities in mind.

Due to the change in the structure of the public during the last decades, with high privatization rate of what was earlier public agencies, it is now time to have a look on how the society has developed itself, and how the facilitating and utilizing of the new structure of public society is met. The project group

thinks that there is a need to look at how the PPPs has performed compared to those traditional ways of acquiring and constructing roads. Thus, it is very important to have a development of the road infrastructure that can match the ambitions of the government, as well as the NPRA and the society itself.

After the Norwegian elections in the autumn of 2013, the parties that established the new government was the Conservative party (Høyre) and the Progress party (Fremskrittspartiet). In their government platform, the parties state that they want to put high emphasis on developing infrastructure. They state that 100 billion NOK is to be put into a fund, who is set to be done over a five-year period. All return from the fund, is set to be used on developing rail, road, public transport as well as communication network. In the proposition, it is stated that the newly formed government want to contribute to better analysis regarding socio-economic benefit from infrastructure projects. Better prognoses regarding traffic growth and such must be taken into account, with reason in that projects should be built to include expected traffic growth over the planned life span of the project. The government also want to reduce the planning time, especially by having a less bureaucratic and cumbersome system for how objections are added and handled. The goal is to cut the time in half. The government aim to organize all large road and rail projects as Public-Private Partnerships, as they believe that is the best-suited way of conducting these projects. (Regjeringen, 2013a)

All subjects above, encourages the examination of the contract strategies in use today, and identifying how a total operation from a private operator has worked in practice before. With background in this, the search is to see how the Norwegian road authorities can utilize it, and contribute to constructing roads that can withstand the tooth of time and still be built within the time horizon prospected by the government. The more it is possible to understand this, including seeing what triggers maintenance and other operations on the roads, there is a possibility to give a clear view on how this expected project development can be used in practice. With subject to data availability, the belief is that this is possible, at least to have a comparison with regard to what is best today, both with thought on quality, time use and best use of public money.

To find a solution to this, a collection of as much information as possible from projects that are comparable and use the numbers found to create a comparison, hopefully via a model that will show the difference in costs from the two types of contract types. The aim is also to look at other challenges regarding the contracts. Some natural challenges about that, is for example contract formulation and how change orders are handled in the different situations. Seen from the NPRA side, it is also about placing risks, and how the work stock is prioritized. The challenge is to identify why one of the options deviate from the other and how this affects the final product; the road used by the broad public mass.

In the specialization project last semester, the project found that the public is strongly emphasized to use LCC as selection criteria in tender competition processes. However, there were many challenges left in order to being able to utilize all the possibilities given. Some findings from the project, was that it was hard to prove which project in fact was the most cost effective, due to limited knowledge among the decision makers, including politicians at the initial part of problem formulation. What the project found as the weakest link was that the planning was not good enough. The project found the planning being too weak in the long time perspective, considering LCC. The reason for that was that the public earlier used an all too high discount rate, almost neglecting the costs of the road in the time span towards the end of life. On the other side, the instances eligible for objections during the hearing period may have been too comprehensive thinking of all discussion and time used only for small changes of path, for example. The new government has mentioned this as something to improve in their platform, and seek to shorten this planning phase. This is a challenge the project hope to identify

possible solutions to during the problem. However, it may be challenging because the PPPs have not been in operation for many years yet. Thus, it may be hard to obtain and identify solutions to problems who have not yet emerged. In this project, the aim is to specialize this even more into road construction and the TP vs PPP perspective. LCC is of course very important, but the whole LCC as the project defined it in the last semester, will not be investigated here. The reason is that the NPRA, independent on which contract strategy is used, will be in hand of some of the LCC activities, especially in the front-end phase. This difference will be described closer in the theory part.

In the specialization project it was also mentioned that selection criteria can be challenging to defend in case of which offer is in fact the best. There has been public contract cases taken to court, with the result that the public party was forced to pay a compensation to the losing part, because it lost the initial tender competition due to unclear selection criteria. In the specialization project this fall, there is mentioned two such cases, where the public authorities lost due to choosing a part that could not fulfil the criterion in the tender formulation. However, a choice has been made not to discuss this further, because there is no field in this thesis where it is suitable to include. The reason for not including this is that such challenges are of executive manner in this setting. The difference between two tenders are normally not big enough to make a huge impact on a long time basis, and there is a feeling that a deeper understanding of this is not relevant in this project.

This thesis seeks to find what contracts and financing possibilities there are, as well have a look at what the different types offer. Traditionally, those who has given the lowest total cost, considering construction cost, win tender competitions. The only pre-conditions are that they pass the initial quality test, including environmental and quality issues. The aim is to find out whether it is possible to use the market even better in order to find a solution to build roads with a span longer than the finalisation of the road. By that, the meaning is taking the operation of the road into account. Will the road have a cheaper lifetime cost if the initial quality of the road is better?

In order to answer these challenges, the aim of this thesis seek to:

(1) Create an overview over contract details in the three existing Norwegian PPP projects and compare it to the traditional contract formulation regarding both construction and later operation of the road. The aim is to find a way to describe the governance and payment scheme for PPP compared to traditional contracts.
(2) Consider factors that influences the LCC in the PPP contract E39 Klett-Bårdshaug, and evaluate findings with traditional construction and operation contracts.
(3) If possible, find a conceptual estimate for the LCC at E39 Klett-Bårdshaug, compared to LCC for similar road elements (road in the day, bridge, and tunnel) from traditional road construction contracts regarding both construction and operation.

2 METHODOLOGY

Methodology is a means to solve problems and a way of coming up with new knowledge. Any medium or remedy that serves this purpose belongs in the arsenal of methods.

In this chapter, a brief introduction to scientific methodology is given. Methods used in the project are presented, together with why they are chosen. The data collection process is presented with emphasis on how it is done, the validity of them, and how and why they may deviate from what is actually true. The project will mention what the project require from the data to be worth using in the project.

2.1 CASE STUDY RESEARCH

This project must be seen as a case study. A case study is a method where the researchers observes and obtains information of a phenomenon, which already exists. The method is used to examine individuals in their natural circumstances. Unlike an experiment where the researchers has full control over what is going on and can separate between events in the research and the outside, the researchers has limited or no possibility to control what is going on in a case study(Yin, 2009). For us, the case study enables us to get a realistic view on how the different contract forms works in practice. The project have no chance whatsoever to affect anything in the projects nor the procedures. Thus, the project are only investigating the pros and cons in the PPP and the TP. In order to answer the problem statement questions, the project have used an individual case study. Individual case studies can be distinguished in two different types, holistic and embedded (Yin, 2009). The holistic case study is a description one can use if there are no clear sub units in the case. In the embedded case study, you have distinguished sub units in the case (Yin, 2009). This case must be regarded as an embedded case study. Because the project have a case where TP is compared to PPP, and the project have several sub units in the case, which the different projects must be identified as.

2.1.1 Research method

Research method can be defined as «The process used to collect information and data for the purpose of making business decisions. The methodology may include publication research, interviews, surveys and other research techniques, and could include both present and historical information.» (businessdictionary.com, 2014)

The data collected via research is used to answer the problem statement in the best possible way. In scientific work, one can say that the research method is a systematic effort of getting knowledge (Redman, 2009).

2.1.2 Quantitative research

A quantitative study involves few variables, but a large set of data.

«Quantitative Research is explaining phenomena by collecting numerical data that are analysed using mathematically based methods, in particular statistics» (Aliaga, 2000)

The quantitative research aim to isolate variables from context and measure correlations between them. The data set is comparable and able to assign meanings of those involved via the answers given. The quantitative research should involve relatively questions. Quantitative research should prove high verifiability, and be very precise (Sjøvold et al., 2013).

2.1.3 Qualitative research

A qualitative research involves many variables, in a small set of data.

«Qualitative researchers are interested in understanding the meaning people have constructed, that is, how people make sense of their world and the experiences they have in the world.» (Merriam, 2009)

«Qualitative analysis: A process of examining and interpreting data in order to elicit meaning, gain understanding, and develop empirical knowledge.» (Corbin and Strauss, 2008)

The qualitative research method is context sensitive, and is about understanding more complex situations and dig deeper into the challenges you want to solve. Emphasizing the perceptions of those involved is an important part of what one is able to do compared to a quantitative research. Qualitative research involves a smaller set of involved participants, and those who perform the study is able to do a more in-depth analysis of the data collected from each research participant (Sjøvold et al., 2013).

2.2 CHOICE OF METHODOLOGY.

Choosing right methodology is important in order to solve the problems you have identified upon start-up of the project.

This thesis has a focus on doing a comparison between contract strategies for Norwegian road construction projects. The main task is comparing two financing options; PPP versus a TP. TP involves separate contracts in construction, operation and maintenance. However, the same contractor can have all contracts, but they are independent from each other. In PPP, the same contractor is responsible for all these parts. With that as starting point, the natural way of attack will be a straightforward quantitative analysis with focus on costs. However, because of uncertainty regarding what information the project are allowed and able to obtain, the project have to prepare for use of both qualitative and quantitative methods and create two different strategies. One with all data available and one with only limited data available. The project will as early as possible make clear what is available and then aim the project into the path that is most suitable for what data the project are able to obtain.

The main challenge the project are prepared to meet in the thesis, is limited availability to data. Doing a cost comparison is only worth to put really much emphasis into if the project are given permission to view the actual cost data. The project simply need verified and good data to see the whole picture. The project have some indications on that having access to the best possible know that it can be difficult to be able to have access to all data. Due to business practice and contract agreements, there may be limitations regarding what the project are able to access of cost data.

Another question regarding cost analysis is what kind of costs to use. As this master thesis is to be used by the NPRA, that gives us two main alternatives to look at. Which of the alternatives the project will end up using, may be subject to availability, as well as being a discussion of what is most appropriate in the setting of the thesis. Regarding the traditional procurement contracts, there are several elements added to the final cost, and the project must decide upon which costs who meet the purpose in the best way. Collecting costs can make us able to do a cost comparison, even though a straightforward analysis will be relatively shallow and not touch into the deeper source of the data.

As the NPRA are receiving tender bids on all their contracts, doing a straightforward cost analysis should be easy if the project get access to the correct data. For the PPP contracts, the project have the total sum, and for the TP the project can add construction, operation and maintenance costs. The

project can use the tender sum as base for the calculations in both alternatives, and then look at how that cost estimate deviate from the factual cost after the contract is finished. The project see that as an option, because it is what they must pay to the contractor that in the end is their, and thus the public, cost. On the other hand, the project now from the NPRA that they do cost analysis and that are cost data on different parts of a road project. These data are collected in order to identify in which range the tender price should be. Those data can also be used as basis for the analysis. Regarding data in the PPP project details, the project already from the beginning know a little bit about how it works, and that the project do not know what information will be available. What data to use must be decided later, when the project know what data which is available to us, if any. What to use if both are fully available must be seen in connection with how the rest of the project passes by, and what suit the thesis best. The availability of these data will decide very much of the structure of the project. If the project find these data comprehensive and worth excessive analysis, the quantitative part will be very important. Because the project know that there are different contract parties with different interests in these costs, the project know there may be challenging to bring these data into the thesis. However, the exact cost are neither what is important. What is important, is that the project can access triggers in the contracts and be able to analyse which incentives, bonuses and penalties there is for deviations from the agreed standard.

If the project, on the other side, do not get access to all available data regarding cost analysis, the project must dig much deeper into the qualitative parts of the roads. The qualitative method will focus much more on the performance of the road, with emphasis on quality for the users, contractors and the NPRA as client. Interviews with involved parties is necessary, and the project hope to reveal deviations from different types of contract, and then do an analysis of what is ups and down with the different findings.

This master thesis consists of one part with a quantitative comparison based on reports ordered from the NPRA. The report gives us a good view on how costs on operation of the road is driven, and how costs are added up. The report is detailed, especially regarding road in the day, where the report take all kinds of conditions into account, regarding both traffic volume, speed limit and climate. Being a project manager is not about creating all data ourselves. Because none of us in the project group has any broad knowledge on how costs are driven, the project feel that the report made from ViaNova on mission from The NPRA Central Norway give us the required data. By having this information, the project have enough data to calculate how operation costs are adding up on roads in this region of the country. This is operation costs calculated from traditional procurement costs and is a good tool to use also to the authorities who create the tender competition for interested companies. The report is comprehensive, including all operation and maintenance costs to calculate the costs of a road made on a traditional procurement basis with

The initial aim of the project, the ideal plan who was thought of as the best possible result, was agreed upon during the autumn of 2013. In meeting between the project group and The NPRA, the project saw that a cost comparison between the TP and PPP discussed during the specialization project. As far as possible, it is the life cycle cost of the project, regarded from the public point of view, who are the main goal to find. This is, as briefly mentioned, done best as a quantitative study, as comparing costs is a something measurable, thus quantitative.

2.3 LIMITATION OF RESEARCH

As mentioned briefly earlier, this study is made by project manager students without any distinct knowledge within the field of constructing and maintaining roads. Thus, this is a study with a wide focus on collecting verified information from trusted sources. Verifying and utilizing available data is important, and the project feel that being investigators "in the field" may be a wrong way to attack this. Thus, the project have decided that the project are only into collecting data already available, alternatively suggest information the project feel necessary, rather than doing pioneer work ourselves. This is especially important regarding technical questions and the ability to verify information. The project must trust the information, and the analysis in out thesis is thus based on the data the project find available and verifiable.

This project is considering major road projects only. This means roads with a, in Norwegian conditions, high ÅDT, exceeding 6000 at the starting point of the road lifespan, and 11 000 towards the end of private ownership life. This excludes most roads in Norway, thinking of operation costs. As the project are having focus on PPPs, there would anyways be nonsense to include lower YDT, because there are no PPP projects with a lower traffic volume in use today. In other words, insufficient comparison material is given if the project search to compare lower volume of traffic.

The project has also chosen not to have a specific view on the planning of the road trace. This project is focusing on large construction projects after the front-end planning phase, which implies that the project exclude hearings and planning regarding best socio-economic benefit. There are very many interesting discussions regarding how and when a road should be made, also where the trace should be. In tunnel or around the mountain, for example. Due to the specialization of this project, the project do not enter any discussion regarding placement of the road trace. This is neither a part of the PPP, because politicians and other authorities determine the trace after several decision-making processes with objections from many instances. There has been discussion about the cumbersome processes needed in order to agree and confirm projects. As this process is of a much more political discussion and thus on the edge of the focus, the project feel it is not the table and pass it in silence in this thesis. What parts of the planning who will not be elaborated further is described closer later.

The PPP projects are relatively new now, which means that none of the projects is yet to be transferred over to public operation. The contract state that the roads are being transferred over to the public after 25 years, in other words will the first PPP project not be completely finished until 2030. Because of that, some of the challenges one can expect to meet regarding the projects, are not visible yet. An interesting part to look at will be how the quality of the road develops when 2030 are approaching. Experiences regarding the quality and condition of the road at handover will be very interesting to have knowledge about, but will not be an experience until another 21 years. Thus, this is a thought the project are not able to look at, by natural reasons.

2.4 DATA COLLECTION METHODS

2.4.1 Literature study

2.4.1.1 Purpose

A literature study is a systematic way of reviewing relevant written literature about a theme or problem statement. The purpose of a literature study is to obtain an overview of what is already studied in the field of the theme who is chosen (Dalland, 2000).

Regarding this project, information obtained in the literature study is made based on sources of both electronic and written manner. The literature study are made with sources who are available to the public. Norwegian regulations and legislation, handbooks from the NPRA and governmental documents, such as the national transport plan (NTP) and press releases, are fully available to the public. Some of the more specific contract documents are obtained via the NPRA, and are thus not fully available to the public without any extra effort.

2.4.1.2 Purpose in this project

The literature study performed is done in order to obtain a broad view on how road construction projects are performed in Norway. PPP is relatively new, and none of the projects has even reached the halfway of its life cycle. Thus, it is important to obtain knowledge on how these projects are planned, and what mechanisms there in connection with payment, operation and maintenance both on the PPP contracts and parted conventional contracts. The background study has proved worthwhile in order to get the knowledge demanded in order to understand what is important in this project. Some of findings in the literature study is presented in this project, as the problem statement involves background information.

2.4.2 Interviews and observations

2.4.2.1 Purpose

Interviews are a useful method to use in order to dig deeper into questions you want comprehensive answers to. By performing interviews, you want to be able to find information you would not be able to obtain via a questionnaire/survey or other more superficial research methods. Via interviews, you may be able to introduce more of the human dimension to the problems you are aiming to solve. You are also able to identify personal perceptions, for example identifying information who may be sensitive. This can for example be information one may be negative to answer in groups or meetings, but who is easier to reveal in a more trustful setting (Birmingham:University, 2006).

2.4.2.2 Advantages

Advantages of performing interviews are that they are very useful where one are interested in obtaining special information, including personal feelings and opinions. They do also make us able to ask questions of a more personal manner, as well as adapting the questions to those you are asking. If a question is hard to understand, it is also very easy to clarify the question immediately, in order not to have any misunderstanding in the question formulation. A final advantage regarding interviews is that a very high response rate is usually obtained, because the personal addition usually gives people a higher interest in answering the questions(Birmingham:University, 2006)

2.4.2.3 Disadvantages

Creating interviews are very time consuming, and may thus be very costly(Birmingham:University, 2006). As the project are two persons in the project group, this may create deviation in how people answer questions who originally are meant to be asked in the same way. Thus, it is important to either be very aware of how to ask questions, or even agree upon that only one of the group members perform all interviews. Alternatively can both persons be present at all interviews. However, the project do not see that as a very good alternative, because it can lead to the interviewee gaining a feeling of being inferior in the setting.

2.4.2.4 Purpose in this project

Being able to ask questions independently as well as keeping away from any form of biased questions is from the point of view crucial in order to have answers you can verify and use with high accuracy in the study.

The qualitative study includes interviews with contractors, where the aim is to find the private sector's vision on how to perform construction, operation and maintenance activities on the road. Finding their vision regarding activities are very important, in order to see how today's contracts can be formulated even better. The project also hope to be able to get the construction companies to share their view on whether there are differences between the public and private perception of an optimal construction of a road. The project also want to observe how the private partner are operating the roads, and whether plan could have been better if the roads was built better to suit operation challenges. Via interviews, the project also hope to obtain information from the private on how their contribution to public roads makes their solution worth it in the long run. For example reveal how they aim to include technological leaps that are not specified in the contracts, regarding for example lifesaving advances, a case where it is believable the NPRA must buy a change order to make the leap count in the contract period.

2.4.3 Questionnaire

2.4.3.1 Purpose

Performing a questionnaire is very important to obtain statistical data in a research project. A questionnaire can be both qualitative and quantitative. It depend on more variables, but mostly on the question type and the selection of participants(The.Economics.Network, 2013).

2.4.3.2 Advantages

With careful planning, questionnaires can yield high quality usable data, achieve good response rates and provide anonymity, the latter encouraging more honest and frank answers, than for example interviews. This can help to reduce bias (Marshall, 2005). A questionnaire give clear feedback, and is directly comparable with the other respondents as all the questions are uniform. A questionnaire is also able to identify distinct differences between groups of people, if conducted correct (The.Economics.Network, 2013). This require that questions regarding what is the purpose to find in the questionnaire is identified and distinguished.

2.4.3.3 Disadvantages

A common argument in disadvantage of use of questionnaires is that there are normally hard to obtain a good response rate. An argument for that, is that there seldom is a strong motivation for respondents to respond (The.Economics.Network, 2013). There are some ways of motivating, for example by drawing one or a few of the respondents, and let them win a prize. However, that may cause deviation in the study, because people interested in the prize may in general have a different perception than those who not are interested in the prize, and thus decrease the validity of the research.

The validity of the data may also be lower than other research methods, because the ownerships to the answers you give in questionnaires often feel less important than in a more personal setting, like an interview. Another argument is that questionnaires can be misused, and then lead the data even more away from the factual perceptions (The.Economics.Network, 2013). There are neither a quality control who can prove that the person who filled in the form is actually the person you wanted to ask (Marshall, 2005).

2.4.3.4 Purpose in this project

In this project, the project have chosen to do a questionnaire to control what differences there are between contracts responsible for PPP and a TP. The project have chosen to conduct a survey among responsible persons in maintenance and operation. For us, the project hope to use the answers to be able to identify what differences there are between the two contract types, as well as getting an

impression of what the companies who are working daily within the branches are experiencing as pros and cons with their own contract.

However, the project have to be aware of that there may be few respondents to the questionnaire. Simply because the project does not have too many contact persons in operation and maintenance, neither are there many people responsible for this. Thus, the project are very dependent on getting contact information to those involved, and hopefully get them to respond. Especially thinking of the PPPs, where the project have only three projects as reference. The questionnaire seeks to address specific differences between operation and maintenance in a PPP versus a TP.

2.5 DATA VALIDITY AND RELIABILITY

The methods used demands from us that the project define whether the data are reliable and valid.

Being reliable means that the data are covering the parts of a problem that the project want to solve. A method of ensuring that is to secure that are sources are being put into a setting that is very similar, which do not create any difference in perception regarding the questions being asked. Reliability failures emerges because of random failures in the measuring process (Samset, 2012). An example on a low reliability data set, but still with high validity, is to ask financial people how the stock market will look in a couple of years. The answers will probably be within a range, but will vary a lot and not be reliable as proof of how the market will look in a couple of years. As presented below in figure 1, Knut Samset's model shows how the reliability can be low, even though the validity is high.

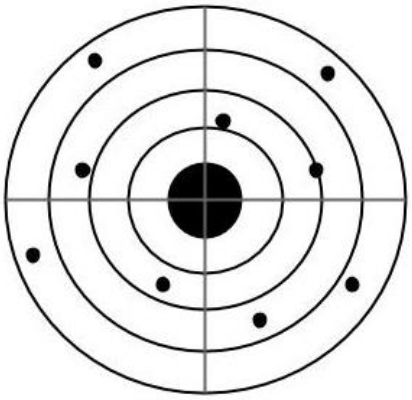


Figure 1 high validity, low reliability (Samset, 2012)

Securing high data validity is an important part of ensuring that your project is using correct sources for data collection. High validity is important to show that the findings in the project are trustworthy and verifiable. A method of securing high validity is to ensure that construct validity are verifiable. Construct validity refers to which degree a test measures what it claims, or purports, to be measuring (Brown, 1996). An example of a high validity research that slowly deviates into a less valid answer will be to ask a group of engineers the correlation between the diameter and circumference in a circle, pi. The factor 3 and the first two decimals will prove very valid. Every engineer know that 1 and then 4 is the two first decimals. However, the following numbers will probably deviate, and prove less valid. Many of the participants will probably be able to remember maybe one or two more, but the data will not prove valid enough to be used in a project about the number. This also explain that doing a good research and know what to expect from your data sources is very important in order to verify good validity in your data. If the data are deviating from a good validity, you can end up with false data, which you present as true. This mislead a lot and do not make the work performed trustworthy. A practical example on how low validity, even though there are high reliability, can affect a project is presented below in figure 2.

2.5.1 Reliability and validity in this project

2.5.1.1 The literature study

The literature study is based on official and public sources. Because the project is using mostly public sources, it is easy to find and thus verify the data. However, as much of the literature study is legislation and signed contracts, there are no possibility of crosschecking such data. However, the project neither see a validity nor reliability issue to this. This is because such documents are very reliable and describe all parts very well.

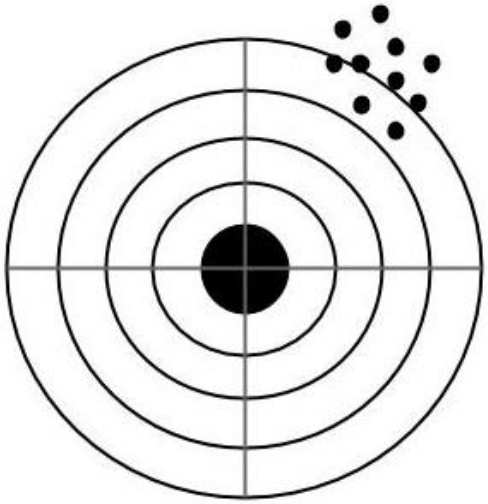


Figure 2 High reliability, but low validity (Samset, 2012)

2.5.1.2 Interviews

The validity of the interviews in this project is subject to validity of those who are interviewed. The persons involved is those responsible for contracts and projects investigated in this project. By that, the project feel that the data obtained from the interviews is valid.

2.5.1.3 Questionnaire

The questionnaire in this study is aimed towards responsible persons for maintenance and operation on Norwegian roads, generally in the central region, Møre og Romsdal and Trøndelag, as well as responsible people for the trial PPPs. Due to trouble in having contact info for responsible persons for operation and maintenance all over Norway, the selection of participants was rather narrow. However, the questionnaire was never meant to prove anything in particular, rather support or not support other findings in the thesis.

2.6 STRENGTHS AND WEAKNESSES OF THE STUDY

The project group is without bias and is independent from any organisation with a stake in such projects. The project group do neither have any stake in the project and are only interested in presenting the results without any other agenda than presenting the perception of the alternatives. The project group sees this as a strength for the project. The integrity is thus not at question. Another issue, which can be both a strength and weakness, is the limited experience within the field and area. The strength by that is that the project do not have any perception of what to expect. There is no biased view on any part of the project, and by that, there will not be any problem to evaluate all options equally. An experienced person on the same area may refuse to have a look at parts who to this person seem unimportant, but which the project in the end find interesting. That can of course also be a weakness, because there can be restriction on what the group is able to identify as issues, something an experienced person easily would identify. The project group's knowledge within the area is after the circumstances rather good, because of the former projects and findings last semester. Because of that, the project also have a clear view on what is important to have a closer look at in this project.

Since the PPP contracts still have many years to go before they are finished, it would possibly give a better result if this project was done at the end of the contract duration, and not now in the first half. On the other side, as presented earlier with the new government and proclaimed focus on implementing more PPP projects, it can be beneficial for the responsible parties to have an evaluation

already now, in order to draw on the potential findings of this thesis, despite the remaining contract length of the PPP contracts.

Due to few responsible persons for maintenance and operation in the region, regarding both PPP and traditional contracts, the project will not have many respondents for the questionnaire, simply because there are few to choose from. That must be seen as a weakness, because the project group cannot use "the law of large numbers". However, the questionnaire has never been performed to prove any data, but is used more to get an impression on how the responsible persons feel the system works today, and thus identify ups and downs in having a short road stretch to maintain in operation.

Another challenge will arise if the amount of data is limited. Then the quantitative quality of the study will be limited, something that the project group are very aware of could happen. If so, the focus will be changed a little bit, with less focus on having a cost comparison with high provability.

3 THEORY

The theory in this project seeks to clarify all necessary fields the thesis will face. The main idea is to illustrate which areas that has to be emphasised in order to be able to develop road projects in general, and what possibilities the public has with respect to use the money they have been granted and fulfil the criterion set by the governmental propositions. It is identified that knowledge about the regulations for public procurement is important. Knowing what standards are used in the roads that are analysed in this project is also important to understand the development and cost comparison in that matter.

Ascertaining knowledge about the different types of contracts is also important, and during this chapter, different types of PPPs and TPs will be presented. As the government has stated that more effective use of money is important, a broad presentation of LCC will also be given, as the principle is very important in the cost picture in a PPP.

Different discount rates has been used in order to calculate future costs in road projects for decades, and the rate used has often been subject for discussion. A short presentation of how the discount rate contributes to the total cost is presented.

The cost development for road projects in Norway is also presented, because the development of the costs from concept to the initial break of ground and finishing of the project. It is important to be aware of this issue when planning for the total cost of a project.

3.1 NORWEGIAN LAW ON PUBLIC PROCUREMENT

"§ 6 Life cycle cost, universal design and environmental impact.

State, municipal and county governments and statutory bodies must, when planning the individual acquisition, take life-cycle costs, universal design and environmental consequences of the acquisition into account" (Lovdata, 2012)

All legislation around the theme of the project is stated in this regulation. In this paragraph, the most important part of the regulation is presented to introduce the legislation around the theme. The different parts of the regulation that is presented, is parts that comprises with the assignment and what is natural to mention in connection with the issues discussed in the project.

In this thesis, where the focus in general is looking at road construction, part I and III are the most important parts of the regulation. Anyway, part II is also relevant, and will be presented briefly.

Part I consist of general definitions, terms and provisions regarding all parts of procurement. Important content, such as for whom the regulation counts for, what types of contracts it count for, the different thresholds and so on are presented in this part of the regulation.

3.1.1 Whom does it count for?

The regulation covers all public procurements in Norway, which includes the state, county and municipality, including statutory bodies. A statutory body is every body that is there for the purpose of the public, and is not of an industrial business character. The regulation also covers private projects with more than 50 % subsidiaries from the public. (Lovdata, 2012)

In addition, there is a very comprehensive set of documents describing when a business must act in accordance with the regulations.

3.1.2 Contracts covered by the regulation

The regulation covers the contracts covering all items, services, planning and construction of public projects. There are some exceptions to the regulations, but these will not affect the content sorted out in this project. (Lovdata, 2012)

3.1.2.1 Thresholds

The regulation consists of three parts. Due to differences in the size and scope of different procurements, there are introduced different thresholds to sort different procurements. Part 1 are general and covers all groups, part 2 covers group 2 only, and Part 3 group 3 only. The following limits are general, because there are some exceptions. Such exemptions are stated in the regulation, and are in general special cases. The threshold values are presented below.

Classic sector: Purchases which exceed the thresholds under the EEA Agreement, and generally also from the WTO Agreement on Government Procurement, and shall be treated in accordance with regulations part III. If the contract does not exceed the thresholds, rules of Regulations section II followed. Regulations Part I applies to all purchases.

Utility sector: Purchases that exceeds the thresholds under the EEA Agreement, and shall be treated under the rules of supply regulations Part II. Regulations Part I applies to all purchases regardless of value.

There are some other limits as well, but the following are the most important:

Group 1. Procurements with a value of <500 000 NOK excl. VAT.

Group 2. Procurements with a value <1,6 mill NOK excl. VAT if a service or good, or <40 mill NOK excl. VAT if a building and/or construction project.

Group 3. Procurements with a value >1,6 mill NOK excl. VAT if a service or good, or >40 mill NOK excl. VAT if a building and/or construction project.

The value is determined based on the contractor's believed value of the project, and there are no room of any kind to split, avoid or misuse these limits. (Lovdata, 2012)

Part III: Procurements exceeding the thresholds set by the EAA.

The specialization projects will, as mentioned, be focusing on large projects, where the limits of the EAA will be exceeded. Part III of the regulation cover such projects, and most of the legislation covering the project is presented here.

3.1.2.2 § 14-1 Allowed tender procedures

(1) The procurement must be done by open or limited tender.
(2) Competitive dialogue can be used when the preconditions stated in § 14-2 is met.
(3) Competition with negotiations can be used when the preconditions in § 14-3 or § 14-4 is met. (Lovdata, 2012)

3.1.2.3 § 14-2 Competitive dialogue

(1) The contracting authority may use the competitive dialogue when awarding particularly complex contracts.

(2) A contract is particularly complex when the client is not able to:

A. In accordance with § 17-3 (requirements for performance and use of technical specifications) objective to clarify the technical terms which may meet their needs and objectives, or

B. objectively specify the legal or financial matters in connection with a project.(Lovdata, 2012)

3.1.2.4 § 14-3. Competition with negotiation, by prior publication

(1) The contracting authority may use the negotiated procedure for the award of contracts in the following cases:

- When the offers in a prior open or restricted tender procedure or competitive dialogue is incorrect, or if prices are unacceptable according to standards established in accordance with the regulation.

- In special cases where the item, service or construction contract nature or associated risks do not permit overall pricing in advance.

- Through service contracts where the services to be provided is of such a nature that it can be sufficiently determined as accurate specifications, the choice of the best offer can be made by rules of open or restricted tender procedure. This applies in particular in priority services or financial services and intellectual services such as services relating to the design of work.

- By construction contracts where the work to be performed exclusively for research, experiment or development purposes and not to make profits or earnings of research or development.

(Lovdata, 2012)

3.1.2.5 § 14-4 Competition with negotiation, without prior publication

There is also a chapter including when you can publish without prior publications. The text is comprehensive, but it does not add anything important. In general, it is special exceptions mentioned in the above chapters.

3.1.2.6 § 17-3. Requirements for the performance and use of technical specifications

(1) The contract should be specified by requirements specification or specification of functional requirements. In formulating the requirements, the impact of life-cycle costs and environmental impact of the acquisition should be taken into consideration. It should as far as possible meet specific environmental standards for product performance or function. Whenever possible, the specifications are designed to be given to criteria for accessibility for the disabled and universal design.

3.1.2.7 Selection criteria: § 22-2. Criteria for selection of tenders

(1) The award shall be made either based on the offer that is the most economically advantageous, or solely on the offer with the lowest price.

(2) If the award of the contract is given based on the economically most advantageous tender, shall criteria relating to the subject of such contracts be used. This may include quality, price, technical value, aesthetic and functional characteristics, environmental characteristics, running costs, profitability, customer service and technical assistance, and time of delivery or completion. All criteria that will be applied must be stated in the notice or tender documents. The contracting authority shall specify the relative weighting given each of the criteria. The weighting can be set within a range with an appropriate maximum impact. (Lovdata, 2012)

3.2 ROAD STANDARDS

The NPRA are responsible for all road construction in Norway, and must thus have a set of standard in order to secure that a road built in one region by one contractor is similar to a road built in a whole another region of the country. To make sure that the roads are built with the same perception of quality, the agency has created a set of handbooks that provides guidance for how the road should be built. There are many different parts to consider when planning a road. Hence, the need for regulations for different parts of the road is necessary. The system seem to work relatively fine, even though it may seem cumbersome. The handbooks has gone through a renewal process in order to make the system easier to understand, both for internal and external stakeholders. The handbooks needed for road planning and construction is listed below in table 1, given in the old number format. The new format is supposed to be published in June 2014 (Vegvesen, 2014b).

Table 1 NPRA's Handbooks regarding road standards. Source: (Vegvesen, 2014d)

Handbook number	Handbook theme
017	Road and Street design
018	Road construction
021	Road tunnels
048	Traffic signalling
049	Road markings
050	Traffic signs
051	Work on and along roads
163	Water and frost protection in tunnels
185	Bridge planning
231	Road railings

The road is built in compliance with the handbook 017 from NPRA, from the time of contract agreement. The handbook at the time of planning was from 1992. The road standard from the time is shown below in tables 2 and 3. That equals a "Standard H1, Yearly daily traffic 5000-10 000. Highway class B, level differentiated junctions".

Table 2 The different road standards from handbook 017 valid at the planning phase of PPP Klett-Bårdshaug (Vegvesen, 1992)

	UBEBYGD EL. SPREDT BEBYGGELSE	MIDDELS TETT BEBYGGELSE	TETT BEBYGGELSE
HOVEDVEG	H1	H2	H3
SAMLEVEG	S1	S2	S3
ADKOMSTVEG	A1	A2	A3
GS-VEG	G1	G2	G3

Table 3, H1 highway standard requirements(Vegvesen, 1992).

ÅDT	< 5000	5–10.000	10–15.000	> 15.000
Antall felt	2	2	2	4
Feltbredde (m)	3,25	3,5	3,5	3,5
Skulderbredde (m)	1	1,5	3	3
Midtdeler (m)	–	–	–	7
Skulder mot midtdeler (m)	–	–	–	1
Vegbredde (m)	8,5	10	13*	29
Adskilt gs-veg	Se teksten	Se teksten	Se teksten	Se teksten
Adskillelse (m)	>3	>3	>3	>3
Dekkebredde gs-veg (m)	2,5-3	2,5-3	2,5-3	2,5-3
Skulderbredde gs-veg (m)	0,25	0,25	0,25	0,25

However, the road standards have been updated over the years, and new standards from 2013 present new classes. Handbook 017 of today is listed below in table 4. If the road had been built today, the guideline for the road would be different.

Table 4 Road standard in the Handbook 017 as of today's version.

Dim. Class	ÅDT	Fart	Min. road width
H1	0-4000	60	6,5
H1	0-4000	60	7,5
H1	4000-12000	60	8,5
Hø1	0-1500	80	6,5
H2	0-4000	80	8,5
Hø2	1500-4000	80	7,5
H3	0-4000	90	8,5
H4	4000-6000	80	10
H5	6000-12000	90	12,5
H6	>12000	60	16
H7	>12000	80	20
H8	12000-20000	100	20
H9	>20000	100	23

From today's standard, the H5 suit the traffic volume and prognosis for the PPP E39 Klett-Bårdshaug.

3.2.1.1 Consulting road standards group

The NPRA have engaged a group of professionals to include in the management of road planning. The professionals are external and independent. The purpose of the group is to support the NPRA in decision making regarding environmental and socio-economic consequences of choices and actions in the project. The group is divided in two parts; one committee for road owners, and one for users and other interest groups. The committee of road owners consist of municipalities, counties and people responsible for regions. The other committee consist of interest parties, including both public agencies and other organizations with stake in the surroundings of the road, such as organizations covering the environmental, car owners, cyclists, disabled people and so on. Public agencies are for example the police, social and health services (Vegvesen, 2014d).

3.2.1.2 Deviations from the Road Standards

There are possible to deviate from these standards, for example in cases where local conditions force special design of the road trace. All such deviations must be applied for through the NPRA, and the Directorate of Roads. Deviations must be applied for in the early phase of the project, during planning of the trace. Thus, it will not affect any PPP project, because it is stated that all such deviations from the road standards *must* be applied for and be either approved or disapproved prior to the publication of tender competition (Vegvesen, 2014d).

3.3 FRONT-END MANAGEMENT

Front- end management is the management of the initial parts of a project, illustrated in figure 3. From the period when the idea of the project emerged up until the decision is made to finance the project or not. Research has shown that efforts in the detailed planning phase pay back in the implementation

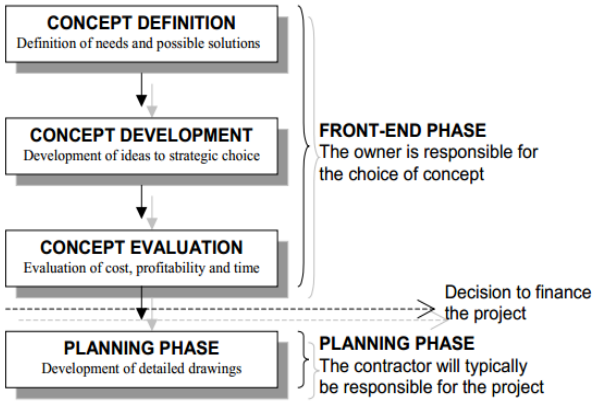


Figure 4 The front-end phases (Samset et al., 2003)

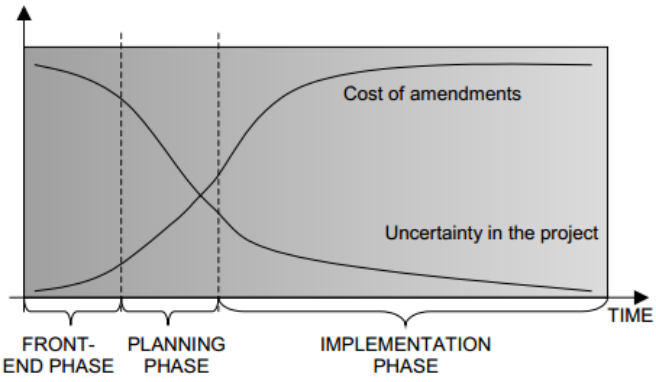


Figure 3 Anticipated correlation between cost of changes and uncertainty (Samset et al., 2003)

phase of projects. The front-end consists of the concept definition, concept development and the concept evaluation phases (Samset et al., 2003).

A general view is that uncertainty affecting a project decreases during implementation, shown in figure 4. With time, the possibility to implement amendments in the project decreases. Similarly, the cost of amendments increases as the project progresses. The uncertainty is at its highest and the cost of amendments at its lowest in the front-end phase.

3.4 PUBLIC-PRIVATE PARTNERSHIP

Public Private Partnership (PPP) is not a new arrangement; it has been practised in Europe for several decades. In 1992 the Major-government in the UK introduced the Private Finance Initiative, what today is regarded at as PPP (OPS-portalen). A key characteristic of public-private partnerships is that the two tasks of building a facility and subsequently operating it are bundled and delegated to a single private contractor, while under traditional procurement, separate contractors are in charge of these two tasks.

According to (Hoppe et al., 2013), a public-private partnership induces very strong incentives to invest in cost reductions, which is desirable if the investments are quality-enhancing, but may well be undesirable if the investments have a negative side-effect on quality. They split PPP into three treatments, one where the contractor in a PPP is a single entity, one where the builder is the main contractor and where he subcontracts with an operator. The third is where the operator is the main contractor and subcontracts with a builder. In theory, the third setting leads to the same investment behaviour as TP. All these three alternatives are viable versions of PPP that one can find. The label PPP covers a number of different arrangements, the UKs' term Private finance initiative among them, PFI is also used (Zheng et al., 2008). Other arrangements are Design Build Finance Operate (DBFO), Build Operate Transfer (BOT), Design Build Finance Maintain Operate (DBFMO) and Build Own Operate Transfer (BOOT).

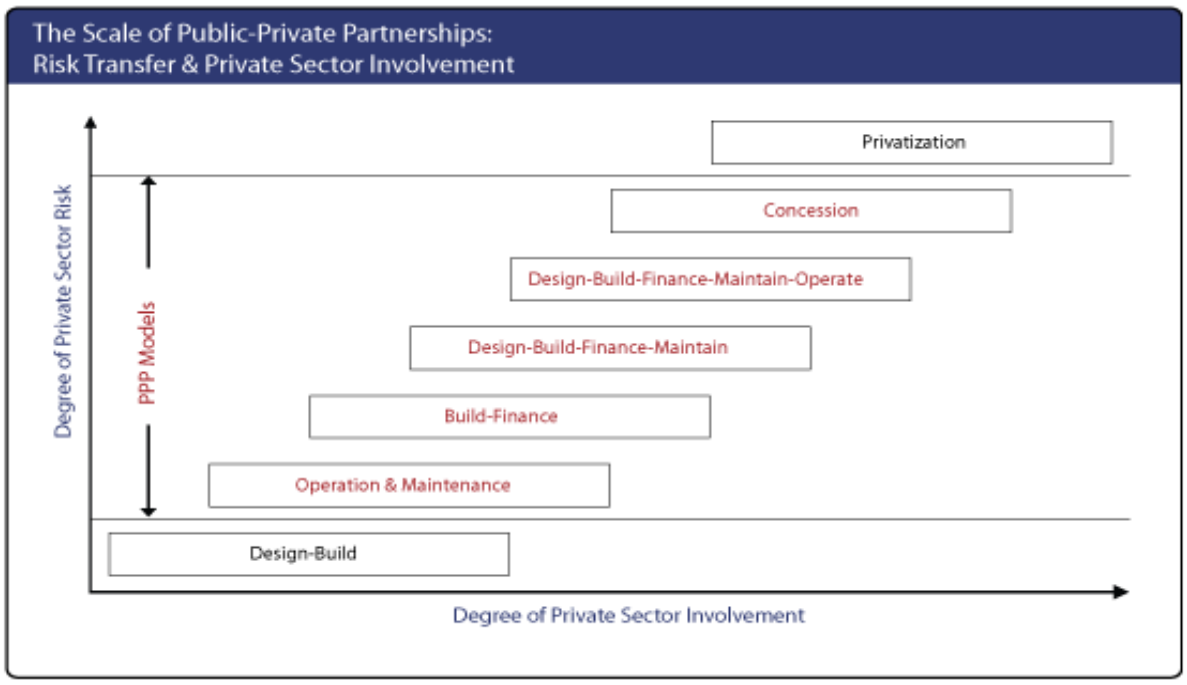


Figure 5 PPP Scale and risk transfer (Public Private Partnership Council, 2005)

As Figure 5 shows, the amount of private sector involvement correlates to the amount of risk that is transferred to the private sector.

One of the differences between PPP and TP is that the private parties are not only responsible for the building, but also needs to take some part in the financing of the project.
PPP is often thought to be an ideal candidate for project financing, where the PPP company comprising of different parties with complex arrangements and contracts that guarantee and secure the

cash flow (Eriksen. et al., 2007). Other differences between PPP and TP is that PPP also often includes either maintenance, operation or both. The latter being the case in the tree trial PPP projects in Norway.

Throughout Europe PPP has been used to a wide degree, and the results wary. It is important to balance the risk between the two parties so that the risk premium is not too high. This is especially important in areas where neither of the parties control the risk, as for instance with a problematic mountain. One of the main arguments or PPP is that the risk is resting more on the shoulders of the PPP companies instead of the public project provider.

In case of the three Norwegian projects, the PPP companies financed the building the road with loans from private instances. The payments from the government first started when the building of the project was completed and the road opened for the public.

There are many critical voices in Norway when it comes to PPP. They often use arguments rooting in some of the failed PPP projects abroad. One thing these voices seldom mention is the difference in the way those projects are financed compared to the Norwegian projects. The projects they point too often have a financing model where the road is supposed to be fully financed or partly financed by toll roads (Bakke, 2011). If the traffic does not meet the prognosis, the government has to pay instead. These prognoses have often been too optimistic, so the government had to pay, making the project more expensive than necessary. In the case of the Norwegian PPP model, the government has kept the income responsibility. The PPP company's income will therefore have no direct link with the amount of traffic, since the traffic volume is hard to control for the PPP company. As a result of the reduced traffic amount, the Portuguese government has gone over to a payment model more similar to the Norwegian one (EPEC, 2011).

There is a toll financing part in the Norwegian trial projects as well. The difference compared to many of the European projects is as mentioned earlier that in the case of Norway, the government has maintained the income responsibility. The income from the toll is therefore an income for the government, which in turn pays the PPP Company for operation and maintenance. Another part of this criticism is that the projects are more expensive since the building is financed with loans, and the interest on these loans make them more expensive than if the financing were to come directly from the government.

In case of using PPP, the procurement situation is especially demanding, and so is the need to follow up on the contract once the procurement of a construction company is finished. Fridstrøm points out that since this is the case, one should be thorough when choosing what type of project that this type of risk transferral is suited(Fridstrøm, 2013).

3.4.1 PPP and legislation

There are no specific regulations that encompasses PPP in Norwegian regulations. Thus, it is the regulations regarding general public procurement that covers acquisitions of the size of PPP as well. The basics of the regulation is described below. However, there has been made a quick guide by the Agency for Public Management and eGovernment (Difi). Among their main tasks, Difi is responsible for setting up solid public procurement procedures. To fulfil their responsibility, they have made the web page anskaffelser.no, who is a portal for public procurers; where they can acquire information, they need in order to perform an approved public procurement. Difi has made a quick guide for contractors to make them remember what is important when facilitating for a PPP, presented on the web page. The following is included:

From the public's point of view, the following points is the client's responsibility when creating a PPP tender:

- Organize a committee with representatives from its own administration, customer, procurement and property division.
- Define the external conditions of the project. Include the contract period, the economic conditions at the end of the contract, operation and maintenance conditions, co-operation during the different phases of the project life, change orders in the contracts and so on.
- Provide legal assistance to all project stages.
- Prepare the market to apply for the project, for example through a tender conference.
- Perform a pre-qualification for the project.

The following criteria's should be fulfilled in order to evaluate the option of PPP:

- Do not enter the model if the project is so small that interested parties do not find the excessive planning and tendering process economically benefitting.
- Do not enter the model with financing or operation as an option. In general, possible contractors will not allocate the resources to put enough resources into those projects parts if only offered as options.
- Do not enter the model if the organization has good resources and experience of similar construction projects.

Benefits from PPPs:

- A competition with a focus on LCC for the facility or building.
- You get several project proposals with associated secondary operation costs to choose from.

Disadvantages from PPPs:

- The competition form is relatively new. There is still not much experience gained from those already executed.
- It is very hard to prepare tender documents. Unless your agency is very experienced, involve external consultants to provide best possible documents.
  Source: (Difi, 2012)

3.5 ORDINARY CONTRACT CONDITIONS.

The road authority has two main ways of organising their projects. The majority of their contracts are organised as what the project in Norway call "Utførelsesentreprise" execution enterprise, and the other is "totalentreprise" total enterprise, which is similar to a turnkey contract. As NPRA describes the "entreprise", they are in charge of the organising of the work between the project owner, construction company and the project planner.

The execution enterprise is as mentioned the dominating contract form in NPRA, where the construction company has responsibility for the execution (Byggherreseksjonen, 2012).

3.5.1 Execution enterprise

The term execution enterprise is not an English term, but a translation of the term used for the most used form of organising projects and their contracts. In these types of enterprise, the owner has the responsibility for the project planning. It is first when there is a detailed project plan, the construction companies are invited to submit their bids. There are different variations in this enterprise form (Anskaffelser.no, 2010). The NPRA normally use the standard NS 8406 –" Simplified standard for

construction contracts" in this form of organising the project. Operation and maintenance of roads are handled with operation and maintenance contracts, and these contracts are a type of execution enterprise.

One thing that seems to be common for these types of contracts is that when a new road is planned, the road parcels are often small/shorter compared to operation and maintenance. This is one of the elements commonly thought to be one of the reasons for the long building time in Norwegian road construction.

The execution contract is often organised in the form shown in figure 6.

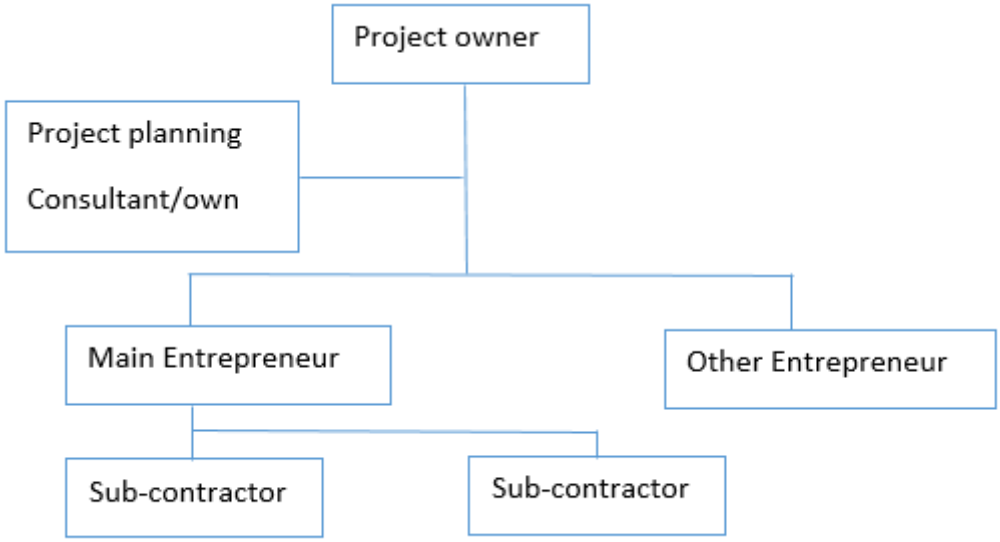


Figure 6 Organising of execution contracts (Sjøli, 2013)

3.5.2 Variants of enterprise contracts

3.5.2.1 Dividend enterprise

In this type of enterprise, the project owner commits to a contract with construction companies for all the different professional areas. The project owner retains control of the project and coordinates the work between the different professionals. He is also responsible for the progress and quality in the project planning.

3.5.2.2 Main enterprise

The project owner gathers the different construction branches in one contract with a main construction company. The rest of the professional areas have their own contracts. The main construction companies is responsible for the rigging and the coordination of the work done by all the other construction companies.

3.5.2.3 General enterprise

The project owner enters into a contract with one construction company responsible for all contracts, including rig and coordination. The construction company is responsible for the project planning.

The project owner responsibilities.

- Organize a control group with representatives for own administration, users, ordering customers and property development department.
- Hire necessary architects and advisors.

- Approve the project plan together with blueprints, descriptions and other contracting documents for the contracting of construction companies.
- Host a contract competition with or without pre qualifications.
- Monitor the work through their own or an external construction manager.(Anskaffelser.no, 2010)

3.5.3 Total enterprise

In a total enterprise, the construction company is given the possibility to influence the project to a certain degree. The intention being to make use of the construction companies experience and expertise. The idea being that this can help both parties both quality wise, and financially.

The NPRA say that they have a goal of using total enterprise contract more in years coming. The arguments are that tis enterprise form can trigger solutions that are more creative, it can give fever demands of change, and it can reduce the project owner's resource use.

This enterprise for is according to NPRA suitable when (Øvstedal, 2012):

- The project is placed in an area with complex terrain
- There is a need for freedom to choose solutions
- There is a need for a development plan
- Not to complex projects
- When contracts include maintenance and operation
- Needs to be a certain size of the project (road – 250 mil NOK)
- Site investigation must be done by NPRA

In the analysis and conclusion chapters, traditional contracts will also include the term total enterprise, making it easier to do a comparison with PPP. If total enterprise is mentioned, then it is only total enterprise

3.6 ROAD DEVELOPMENT CONTRACT.

The NPRA have been developing a new form of organising large road projects. The road development contract is not a contract, but an enterprise similar to the total enterprise. The reason for the appearance of enterprise is the Norwegian national transport plan 2014-2023, where the government announced an increase in the annual funding for state transportation agencies. The NPRA decided that they do not have enough capacity to do all of the planning and designing, so they saw the need to increase the construction company's involvement in early stages of the project planning. The road development contract (Vegutviklingskontrakten) is going to be used for the first time on E6 Helgeland, Korgen- Bolna. This contract has many of the same characteristics of a PPP contract, but the major difference is that he financing is organized as it is for traditional projects. It is a DBMO model, where the NPRA after a pre-qualification stage and a competitive dialogue gives the contract to a main construction company, which has the responsibility for designing, building, maintaining and operating the road for 15 years (Sjøli, 2013). The two-envelope system is used in the biding process.

3.7 TACTICAL PRICING

An issue that the building industry has problems with is tactical pricing. The idea of which is the strategy of altering prices in order to gain an advantage over a competing company. One method of doing this is orchestrating a cooperation with some of you competitors on the setting of prices or the pressuring of them. This form is illegal.

Another method is to price the different parts of you project differently, so that you have an unnatural expensive start of the project, in order to get the biggest payments in the beginning. This depends on

the payment plan following the process plan. If the payment is conducted at the end of the project, this is not an option.

The third option is to price the different posts and units of the project according to amount and the likelihood of possible change orders. An example of this is the case of the tunnel project in Oppdølstrinda in Sunndal, Norway. Here the lowest offer of the construction company NCC was not chosen by the NPRA, which instead chose the second lowest offer from AF Gruppen, which was 43 million NOK higher than the bid of NCC. In NCCs' offer, they had priced 12 different types of construction machinery to 1 NOK per hour. For seven other machine types, they had set the price substantially higher than the normal. NCC put in a complaint with complaints board of public procurement (Klagenemnda for offentlige anskaffelser – KOFA). The complaint was found to be without basis. Although this type of tactical pricing isn't illegal, KOFA concluded that the NPRA should be able to expect real prices when construction companies are biding or a contract (Byggeindustrien, 2013).

3.8 CONTRACT TYPES

The four most common contracts used by the public road sector in Norway today are function contract, unit price contract fixed price, and billable work. The two-envelope system is a contract form that one can expect to see more of in the future (Hæhre, 2013). The amount of risk the project owner and the construction company has depend on the type of contract. In figure 7, one can see that at the far right the billable work, and that in these types of contracts, the risk is almost fully on the project owner. In the middle, the risk is to a certain degree divided between the two parties with a unit price contract. Whilst in the far right the project find the function contract, where the project the construction company takes more of a risk.

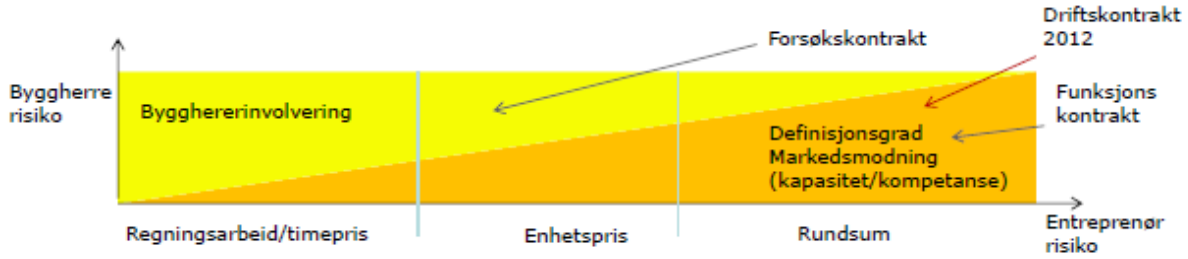


Figure 7 Risk balance in contracts (Byggherreseksjonen, 2012)

3.8.1 Function contract

A function contract is where the road authority has a contract with a construction company where the parameters of the contract contains a function, and not a measurable entity. It is up to the construction company to choose when, where and how they will keep the functionality of for example a stretch of road.

3.8.2 Unit price contract

In this contract type, the construction company offers his lowest price. The project owner has no means of controlling whether the construction company has understood the conditions and parameters of the project, whether they have chosen the best technical solutions or if they have sufficient experience from previous similar projects. The bottom line of this contract is lowest price.

3.8.3 Fixed price contract

A contract that provides for a price, which normally is not subject to any adjustment unless certain provisions are included in the agreement. These can be provisions such as contract change, economic

pricing, or defective pricing. These contracts are negotiated, usually where reasonably definite specifications are available, and costs can be estimated with reasonable accuracy. A fixed price contract places minimum administrative burden on the contracting parties, but subjects the contractor to the maximum risk arising from full responsibility for all cost escalations (businessdictionary.com, 2014).

3.8.4 Billable work

This is a very simple way of getting work done. The construction company that does the work and then bills the road authority for the hours used. Often they have negotiated a fixed price per hour.

3.8.5 Two-envelope system

The two-envelope system is organised in two sections. First, the competing firms submit their proposals in two separate envelopes. The first containing a description of the firms qualifications, personnel and the technical approach that will be followed. The second envelope contains the financial proposal and cost estimates.
In the first part, the competing firms are ranked on the merits of the first envelope alone. When the ranking is done, the second part is initiated. Only then the second envelope is opened and only for the top-ranked firm. Based on that second envelope, the client negotiates financial arrangements with the top ranked firm. If these negotiations result in a contract, the second envelopes of the other firms are returned unopened. Otherwise, the top-ranked firm is dismissed and the second envelope for the next firm is opened, and so on (Hæhre, 2013)**.**

3.9 LIFE CYCLE COSTING

Also known as *life cycle cost analysis* (LCCA)(Olubodun et al., 2010), or *Whole Life Cost* (WLC)(Investopedia.com, 2013, Jadoun, 2010, ISO, 2008), is a means you use when approaching a decision where it is important to determine the most cost-effective alternative among several competing solution alternatives, and the alternatives are relatively equal when it comes to technical grounds.

In general, public procurement is very dependent on price. The final decision regarding which offer to choose in tender competitions is normally measured by this means. As LCC is taking all costs of a project into account, also after put in operation, the tool is valuable and should be regarded as important in decision making in a selection process.

Clarifying the aim and definitions on this term is important to identify what parts of life cycle this project affects. Due to the different perceptions of LCC, the following part of the project is used to clarify LCC, what distinct the different perceptions, and in the end what parts of the life cycle projects this master thesis affect.

In theory, there are several definitions of Life Cycle Cost (LCC):

"The total cost throughout its life including planning, design, acquisition and support costs and any other costs directly attributable to owning or using the asset" (Treasury, 2004)

"The life cycle cost of an item is the sum of all funds expended in support of the item from its conception and fabrication through its operation to the end of its useful life" (Woodward, 1997)

"Sum of all recurring and one-time (non-recurring) costs over the full life span or a specified period of a good, service, structure, or system. Includes purchase price, installation cost, operating costs, maintenance and upgrade costs, and remaining (residual or salvage) value at the end of ownership or its useful life" (Businessdictionary.com, 2013)

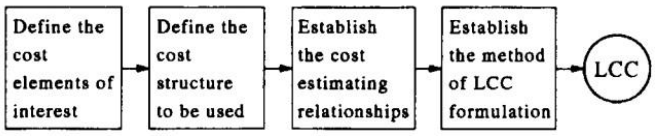


Figure 8 Harvey's Life Cycle Costing procedure (Woodward, 1997)

Figure 8 describe the processes in the life cycle costing procedure, according to Harvey(Woodward, 1997). Below follows a brief description of the steps.

The cost element of interest are all the cash flows that occur during the life of the asset. This includes all expenditure incurred in respect of it, from acquisition until disposal. There is an agreement that all costs should be included (Woodward, 1997).

Defining the cost structure involves grouping costs to identify potential trade-offs, thereby to achieve optimum LCC. The nature of the cost structure defined will depend on the required depth and width of the study (Woodward, 1997).

A cost estimating relationship is a mathematical expression describing the cost of an item or activity. It is used for estimating purposes. Historical data will normally be the basis for the estimation of data in the model (Woodward, 1997).

Establishing the method of LCC formulation involves choosing appropriate methodology to evaluate the asset's LCC (Woodward, 1997).

3.9.1 Life Cycle Costing vs Whole Life Costing

The international standardization organization (ISO) is also into LCC, and is making a distinction between LCC and WLC, where they identify the difference as follows:

"Life cycle costing … is a methodology for the systematic economic evaluation of the life cycle costs over the period of analysis, as defined in the agreed scope …"

"Whole life costing ... is a methodology for the systematic economic consideration of all the whole life costs and benefits over the period of analysis, as defined in the agreed scope …"

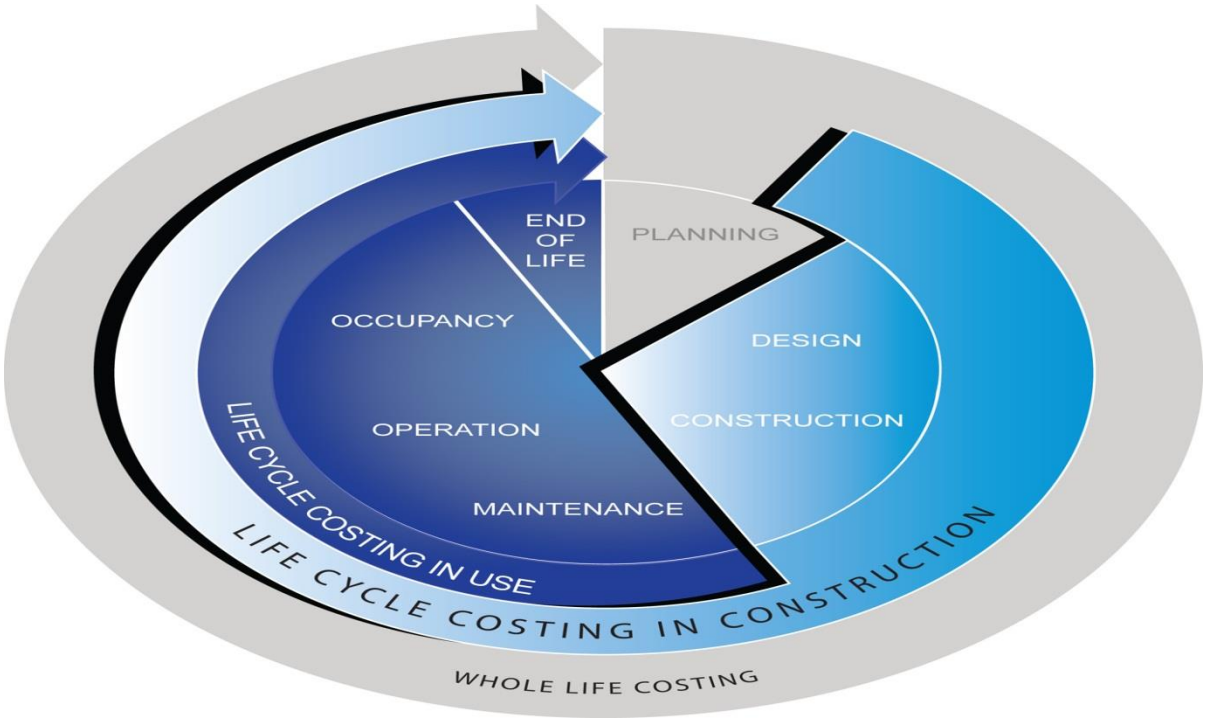


Figure 9, difference between LCC and WLC (ISO, 2008)

As the project can see from these definitions, ISO distinguish between LCC and WLC. LCC is regarded as only the economical contribution, which is made based on product design, construction and then operation of the project, while WLC also include the planning process, as shown in figure 9. Thus, it is important for us to clarify the difference and present what approach the project use when using and analysing LCC. From ISO's model, the project include all parts of costs, especially planning, which have turned out to be a very important part of the analysis. Thus, the WLC approach suits the initial perception and the basis for the definition of the view of LCC. In road projects, the project are of the clear impression that WLC should be regarded as the definition to be used, because the project earlier have found that excessive planning impacts the total cost very much. However, what is necessary to include in this project deviates slightly from this. It will be clarified more later in this chapter.

3.9.2 The purpose of LCC

ISO set the following as pupose of LCC:

"The purpose of life-cycle costing should be to quantify the life-cycle cost (LCC) for input into a decision making or evaluation process, and should usually also include inputs from other evaluations (e.g. environmental assessment, design assessment, safety assessment, functionality assessment, regulatory compliance assessment). The quantification should be to the level of detail that is required for key project stages. The scope of costs included/excluded from an LCC analysis should be defined and agreed with the client at the outset." (ISO, 2008)

With this, it is clear that LCC include all costs related to the project, also those regarding environmental issues, for example. Their definition of the purpose support the initial thought view the project had, which also put emphasis on the surrounding parts of a project, and considers such cost contributions. For example, savings regarding better design, energy saving lights, chemical mix for asphalt binding, and so on.

3.9.3 LCC's usability

There is considerable evidence to suggest that many organizations, both in the private and public sectors, make acquisitions of capital items simply on the basis of initial purchase costs, with the notable exception of military assets (Woodward, 1997). This implies that very few assets are procured based on Life Cycle Cost.

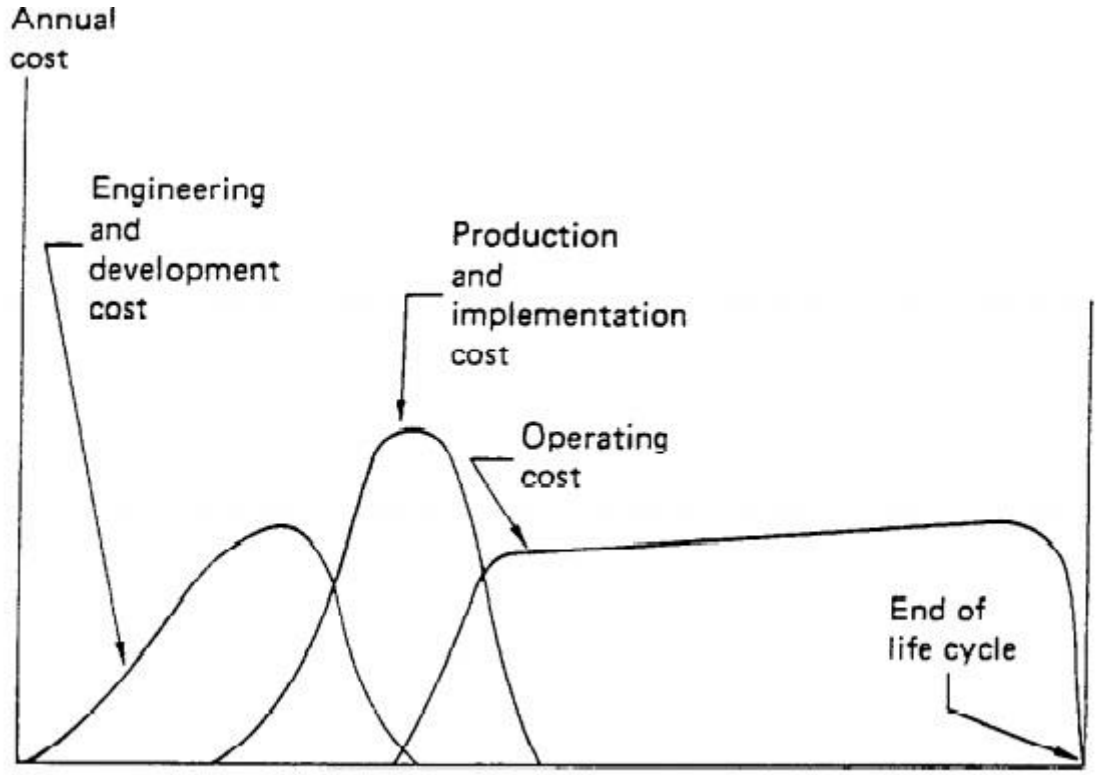


Figure 10 Description of cost stages in a life-cycle cost model (Woodward, 1997)

To easier see where the costs adds up, there is a good way to split the costs in three. First, the Engineering costs, production and implementation cost and then operating costs (White and Oswald, 1976). Figure 10 describes an example on how it can look in a graph.

3.9.4 LCC understanding in this project

LCC will also be an important part of this project. However, some parts of what the project above defined, as parts of LCC will not be that relevant in this project. This is because all the front-end costs connected to trace planning, land acquisition, lobbying, etc. will be individual posts involved in front of the tendering invitation process regardless whether the contract is a PPP or a TP. The quality controls to assure that the budget allocations and cost estimates are within calculated perceptions is also regardless of the contract type. Due to that, in this project, the definition of LCC will not deviate, but what parts of the LCC cycle involved in this project deviate from what this same group defined as LCC in the specialization project. This is done to suit the problem statement in this project.

Taking in the definitions and perceptions from above, figure 5 describe what parts of LCC who affect this project.

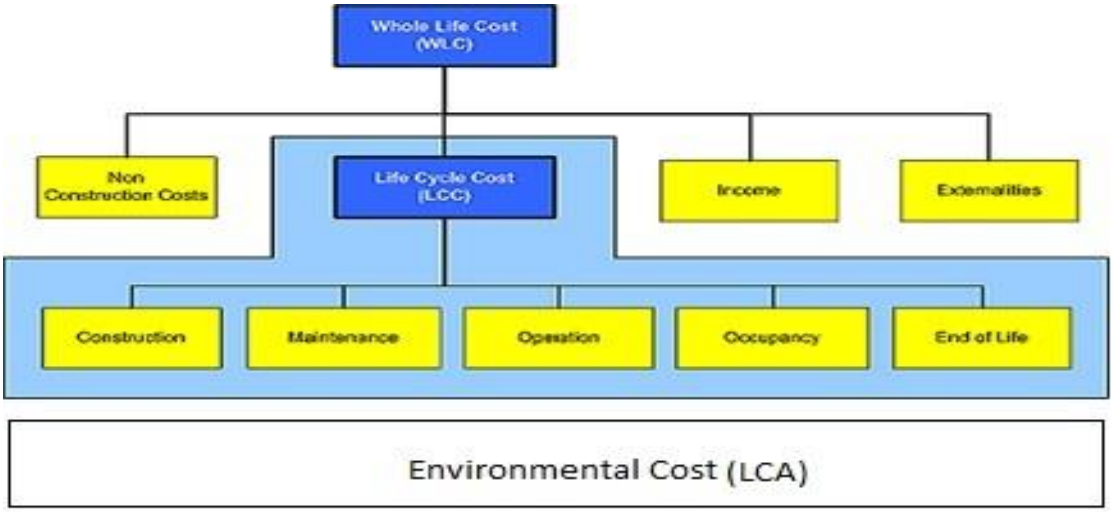


Figure 11 Possible parts of LCC, the light blue area describe this projects focus in the cycle (ISO, 2008).

Here the project can see that WLC include the non-construction costs, which is the planning phase and activities connected with that, for example the agency costs around the tendering process and so on. The lower dark blue box with LCC is what is thought of as costs who are incurring in the comparison the project are condcting. The project could of course add the front-end planning costs as well, but it makes no sense because it will be added to the final cost regardless of which of the two alternatives anyway, and will deviate from the questions the project aim to solve. If the project are able to do that, the project can give a good picture of what is the best option with costs only in mind.

In this project, the initial thought is that LCC is an assessment of a product's total economic contribution through its whole life. By this, the project include planning costs, production and implementation costs, as well as operation costs – similar with the Woodward model. This includes all factors in the Whole Life Costing approach presented by ISO. This implies emphasis on all cost contributing factors, also the planning costs. The whole life cost in ISO's model also include income, but as the public not usually are having very much emphasis on earning a lot of money through projects, this part are not taken into account. Toll roads, for example, are a way of financing a road, and must be seen as a way of just that.

To clarify, will the WLC of the project still be the definition of LCC, but as the planning costs are equal, the project pull analysis of those costs out of this definition, because it will not make sense here. The project by all means, recommend to include WLC when doing analysis of road construction, because thorough front-end planning still is important to be able to do a best-as-possible socio-economic analysis of the new road to be built. This is also in accordance with the QA programme engaged by the government.

LCA, on the other side, is not included in the definition of LCC. The carbon footprint, CO_2 emissions and the cutting down of Brazilian rain forests are not put emphasis on, even though it contributes to the world climate. For us, the monetary value of decisions made under the planning and production process is important. Which again imply that LCA factors can be used as reasoning in the LCC, for example by using more energy efficient lightning, to save electricity costs.

3.10 Discount rate

Evaluating economical values at different times is an important part of both the private and the business life. Discount rate is a versatile tool to express different variables in the same value unit.

More precisely discounting allows comparison of economic impacts that occur at different times by calculating the future value of cash equivalents assessed in monetary value at a particular time. Choosing the present time as value is usual. Price changes over time because the real price ratio change, but it can also be due to inflation, which means the monetary value, or purchasing power, as commodity prices and values measured in is reduced over time (Concept, 2011).

The importance of setting the correct discount rate is crucial in project calculation, especially where LCC is used as selection criteria. This is to the fact that the costs are discounted to the present value. A high discount rate will tend to favour options with low capital cost, short life and high recurring costs, while a low discount rate will favour the opposite; longer life and lower recurring costs. Estimated vary from firm to firm, and no recommendation is usually given in the literature because every project is different with individual risk (Woodward, 1997).

In Norway, The Norwegian Public Roads Administration used a discount rate at 3,5 % as fixed, plus a risk rate varying for the individual project, in the National Transport Plan from 2006-2015, where it was specified. Earlier, the discount rate was set at 7 % (Samferdelsdepartementet, 2003-2004). The rate of 7 % did LCC calculations in the later years of a project almost negligible, which favoured lower initial quality on the construction (Concept, 2011).

A practical example of this can be the theme, construction of a road, where you apart from the initial construction cost, LCC takes into account all the user costs, (e.g., reduced capacity during construction), and agency costs related to future activities, including future periodic maintenance and rehabilitation. The objective is to provide the monetary value for the life of the asset. The practice is to take the estimation of all the different cost elements, and translating them into costs at a particular point in time, enabling comparison. This point in time is usually the present (NPV). (Finnveden et al., 2009) (Olubodun et al., 2010)

The project are of the perception that a lower discount rate should be used in road projects. From the previous knowledge, the project found that high discount rate favour short time projects. As road projects is not short time projects at all, with a lifespan of 25 years of the PPP examples, the values decrease very much towards the later stages of the PPP operation time. As well are the costs in the future very sensible to even small changes in discount rate.

Table 5 value of 100 kr over selected number of years, with different discount rates

Year/Rate (%)	1 %	2 %	3,50 %	4 %	4,50 %	5 %	5,50 %	7 %	10%
1	kr 99,01	kr 98,04	kr 96,62	kr 96,15	kr 95,69	kr 95,24	kr 94,79	kr 93,46	kr 90,91
5	kr 95,15	kr 90,57	kr 84,20	kr 82,19	kr 80,25	kr 78,35	kr 76,51	kr 71,30	kr 62,09
10	kr 90,53	kr 82,03	kr 70,89	kr 67,56	kr 64,39	kr 61,39	kr 58,54	kr 50,83	kr 38,55
25	kr 77,98	kr 60,95	kr 42,31	kr 37,51	kr 33,27	kr 29,53	kr 26,22	kr 18,42	kr 9,23
50	kr 60,80	kr 37,15	kr 17,91	kr 14,07	kr 11,07	kr 8,72	kr 6,88	kr 3,39	kr 0,85
100	kr 36,97	kr 13,80	kr 3,21	kr 1,98	kr 1,23	kr 0,76	kr 0,47	kr 0,12	kr 0,01

As table 5 describes, the project can see that even small differences in discount rate make a big impact some years into time. There may be small differences ending in putting a discount rate at for example 4,5 % or 5 %, but the project see that even these small changes gives a significant difference, with 11 % lower value of the 5 % option over 25 years. This implies that finding a rate that suit the project right, and takes in all risks in a sensible ways is very important.

Tunnels and bridges are built with an intended life of 100 years (Vegvesen, 2014a), a change in the discount rate on those options make huge impact in the cost calculation. 100 NOK will in 100 years be worth 1,23 kroner with a 4,5 % discount rate, but only 0,76 kroner with 5 %. That is 38 % lower value for the 5 % rate. It is by that easy to understand that a higher quality tunnel or bridge made with kroner of today is harder to defend contrary to an action 100 years into the future with an almost negligible value.

In this project, 4,5 % is used for calculation as the number is used on other occasions and proves to be a realistic rate.

3.11 COST AND BUDGET DEVELOPMENT IN ROAD PROJECTS

A report ordered by the NPRA, where the costs from initial plan until finished project for 110 road projects built in the period 1994 – 2006 has been analysed. The results illustrated in figure 12, show that for these traditional road projects, the average total cost is just under 10 % more expensive than planned.

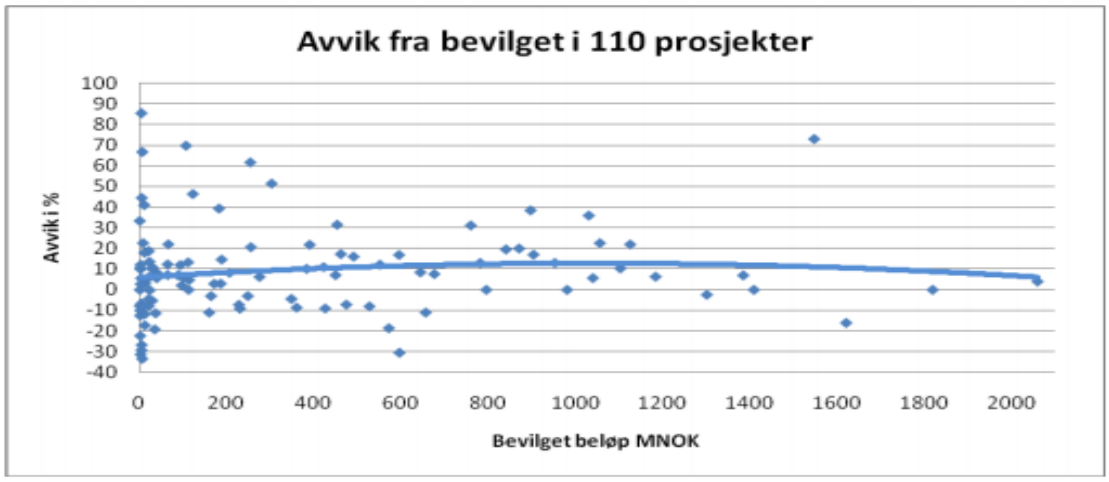


Figure 12 Deviation from appropriation (Torp et al., 2012)

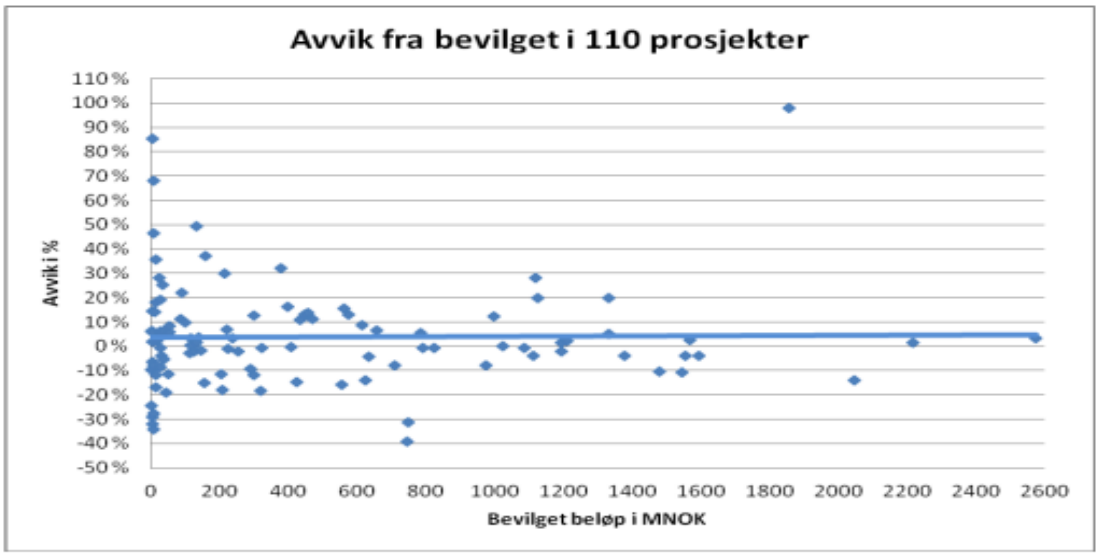


Figure 13 Cost adjusted deviation from appropriation with numbers from "Kostnadsindeksen for veganlegg" (Torp et al., 2012)

In figure 13, the same numbers are cost adjusted according to the cost index for roads, "Kostnadsindeksen for veganlegg". This adjustment shows a 4 % average increase in cost compared with budgeted cost. The average cost of roads in Norway has had a high increase compared to the consumer price index.

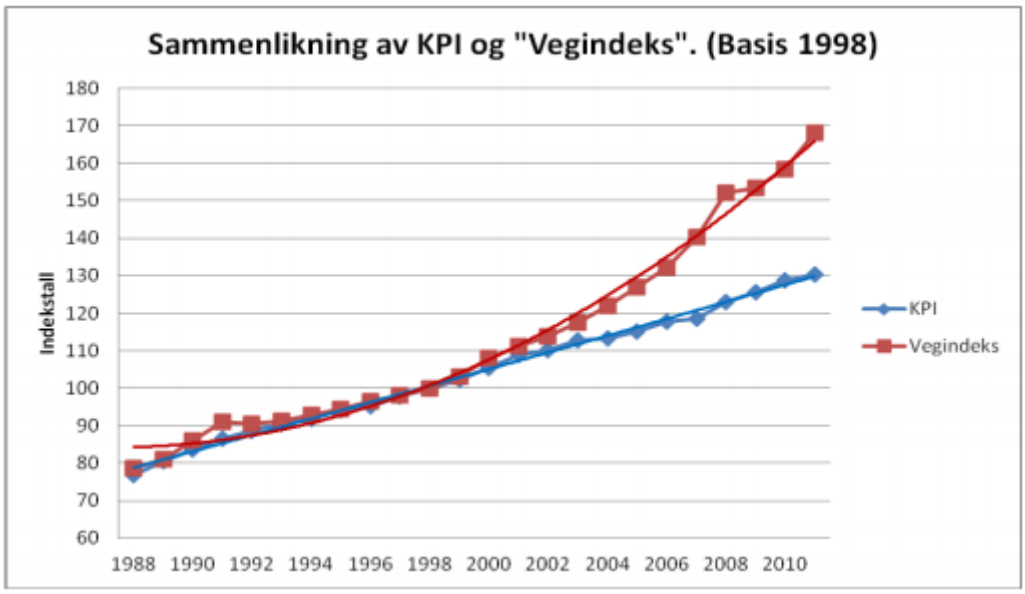


Figure 14 The development of the road index compared to the consumer price index (Torp et al., 2012)

When looking at the development of the cost of building road compared with the development of the consumer price index, one can see that the two has not had similar increase. The yearly increase in financing road building has increased just below 2 % each year the last 20 years, which is similar to the average economic growth. The average cost increase of building a road has in the same period increased 8-9 % a year. Arguments for this increase in cost can be that the increase in total length is not necessarily the goal, but the increase in capacity. By taking the traffic density as a measurement into account, the cost increase has been ca 3 %. Showing that the average decrease in financing have been 1,5 % each year the last 20 years (Torp et al., 2012).

Figure 15, Average cost development through project development (Torp et al., 2012)

In figure 15, the cost development of 34 projects is shown. From the initial estimate when the project is in the national transport plan (NTP), through the awarded sum by the parliament up till the last estimate.

The average time it takes to realize a project from it is presented in the NTP is 8,5 years, and the average cost increase is 70 % (Torp et al., 2012).

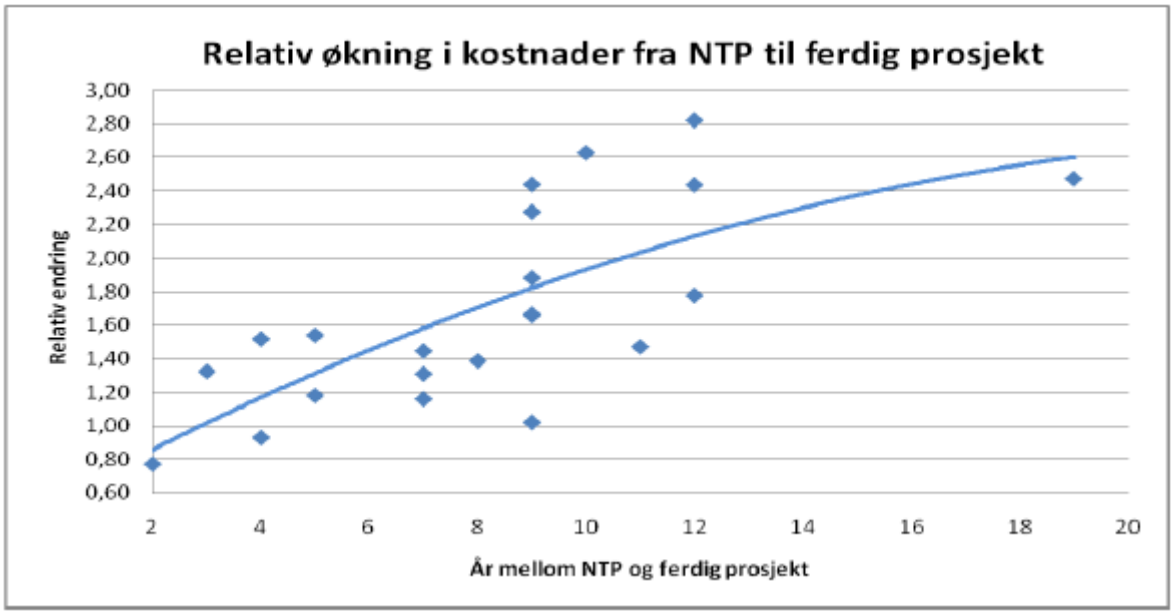


Figure 16 Cost increase from NTP until finished project (Torp et al., 2012)

3.12 Theory Wrap-up

In this chapter, there is been figured out what is important for the theoretical matters of the thesis. When advancing into the empirical data, there is clarified what regulations is important to follow in order to conduct a PPP. Being able to utilize the possibilities, for example through using best possible tender option is regarded as important. Being able to find what distinguishes the PPP, which in Norway is found to be DBFMO, compared to the traditional types of contracts presented, such as the different enterprise contracts. Utilizing these findings contributes to a best possible comparison of the road project types, especially regarding the contribution to the total LCC for the project.

LCC calculations is regarded as a crucial part of the PPP companies' evaluation in the tendering process. The focus on acquiring extra favourable solutions regarding the total cost of both construction and maintenance is important, and from the LCC chapter, it is clear that having a holistic view of the contract period is important to optimize these costs. An optimal solution regarding finding the lowest possible LCC, would be having a holistic view from cradle to grave, but it is not feasible in connection with the regulations for public procurement.

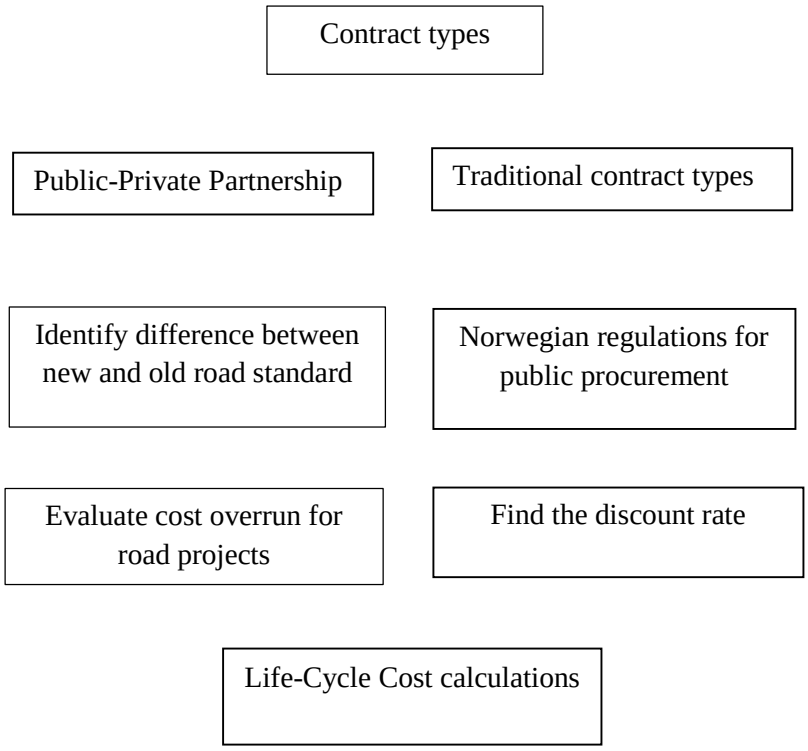
There has also been clarified that there are deviations from road standards at the time of construction of the PPPs and the standards valid for the time being. It is important to have such thoughts in mind when comparing these roads planning for construction of future projects.

By using the knowledge from these parts, as well as being able to set the correct discount rate and take into consideration that the cost estimate for a project normally increases significantly at finishing point.

If able to use this knowledge correct, the foundation for committing a best possible analysis is in place.

3.12.1 **Visual presentation of theory**

The finding from the theory



4 EMPIRICAL DATA

As described in the methodology chapter, the empirical data comes from a questionnaire sent out to selected representatives, cost numbers gathered from the NPRA and interviews with key personnel, representing the NPRA and PPP companies.

4.1 THREE TRIAL PPP PROJECTS

In 2001, the Norwegian parliament voted in favour of building three trial PPP projects. In the Norwegian model, the NPRA is responsible for the development and planning up until the development plan, and to ensure that all the criteria in the contract are met. Looking at this model it is the understanding that that it is similar to the DBFMO version of PPP. The tree PPP projects are:

- E39 Klett-Bårdshaug
- E39 Lyngdal-Flekkefjord
- E18 Grimstad-Kristiansand

As presented in the problem statement, the E39 Klett-Bårdshaug is the focus for this project. However, the other projects will be given emphasis too, because of the different test profiles, with focus on different measurements in order to optimize the life cycle costs, different payment profile and different traffic volumes. The focus will thus be on analysing the main findings for all the projects, and go more in detail for the Klett-Bårdshaug project.

Table 6 Key info of the three PPP projects (Eriksen. et al., 2007)

	E39 Klett - Bårdshaug	E39 Lyngdal - Flekkefjord	E18 Kristiansand - Grimstad
Fremdrift			
Kontraktsdato	07.04.2003	29.04.2004	23.06.2006
Dato veiåpning	30.06.2005	30.08.2006	31.08.2009 (planlagt)
Gjennomføringstid	27 mnd	28 mnd	38 mnd (planlagt)
Driftsperiode	25 år	25 år	25 år
Anleggsinfo			
Veglengde utbygging - hovedvegstrekning	21,9 km	17,5 km	38,3 km
Veglengde drift - hovedvegstrekning	26,9 km	38,0 km	36,0 km
Antall felt	To felt. Strekninger med tre.	To felt. Strekninger med tre.	Fire felt
Organisering			
OPS selskap	Orkdalsvegen AS	Allfarveg AS	Agder OPS vegselskap
Eierforhold OPS selskap (Kilde: Internett)	Skanska BOT 50 % Laing Roads 50 %	Veidekke ASA 50 % Sundt AS 50 %	Bilfinger Berger BOT 50 % Sundt AS 35 % Pihl & Søn AS 15 %
Långivere	Private banker NIB	Private banker EIB NIB	Private banker EIB NIB
Totalentreprenør	Skanska Norge	Veidekke entreprenør AS 40 % Kruse Smith AS 30 % Brødrende Reme AS 30 %	Joint venture mellom Bilfinger Berger og Pihl & Søn AS
Driftsoperatør	Skanska Norge	Kolo Veidekke AS	NCC Roads Otera m.fl
Betalingsprofil	Nedtrappende profil i tre trinn	Jevn betalingsprofil	Jevn betalingsprofil

Some key figures is presented in table 6 together with the companies that own the contract, which companies did the building, which companies that are responsible for the maintenance and the operation, and where the PPP company received financing from (Eriksen. et al., 2007).
The contract length is construction time + 25 years, and at the point where the road has been operational for 25, it will be transferred over into the care of the NPRA. The quality of the road at the point of transferral needs to comply with the road standard defined in the contract (vegvesen and Vegdirektoratet).

The building of the PPP roads is done in accordance with the road standard implemented at the time the contract was written and signed. That road standard is valid for the whole life of the contract. Any changes desired by the NPRA will have to be negotiated as an addition to the existing contract with the PPP company. There are between two and four meetings every year between the PPP company and the NPRA where such desires for change can be discussed and negotiated. It is at these meetings any potential extra payments for increased traffic or good road safety is negotiated.

In case of the three Norwegian projects, the PPP-companies got the financing to build the road from private instances such as banks and investment banks. The Nordic Investment Bank (NIB) has been one of the financers in all three projects, and in the two last ones, the European Investment Bank (EIB) has also come in as a financer. The two partly public owned investment banks often have lower interest rates and better terms than most conventional private banks. The payments from the government for the PPP project started when the building of the project was completed and the road opened for the public. The payments were portioned over the 25-year contract period, but the way the amounts in the three projects were divided is different. E39 Klett- Bårdshaug is in figure 18 OPS III, and the two remaining both have an even profile like OPS I.

According to Lasse Fridstrøm, researcher at TØI "Transport economical institute", there is no need to portion the payments evenly over the 25 years. If the biggest portion is delivered in the beginning of the operational phase, like in OPS III. Then the government does not have to commit itself to large payments over 25 years. The payments following the first large scale will mainly cover the maintenance and operation expense, and an extra part so there is leverage if the PPP company can be

"punished" if they do not follow up on requirements and commitments. With this payment profile, the need for massive loan finance will mainly be limited to the building phase. This phase can be short, since this gives the PPP company a massive incentive to finish as early as possible. In this way one can reduce the binding of capital in the building phase, the building interest is low and the project is less expensive (Fridstrøm, 2013).

As described, over the last 20-30 years PPP has become a common contract form. As such, the PPP used in these three road projects has many similarities with the European contracts, but does wary in some areas. Listed below are the key aspects of the Norwegian model highlighted in TØIs' report (Eriksen. et al., 2007).

- The project is generally planed on a higher level from the road authority, development plans and property acquisition is started.
- There is an invitation for pre-qualification.
- The consortia that is found to be qualified are invited to make a bid (a maximum of 4). The bids are evaluated and initial negotiations are started.
- Two bidders are chosen from among maximum of four to initiate negotiations about the project, and are invited to deliver a final bid.
- One of these two bidders will be chosen for the PPP contract.
- It is normal practice that the PPP company's only business is to build and manage that particular project.
- The contract stipulates the PPP-company's rights and duties concerning the projects implementation, as well as the Norwegian road authority's rights and duties.
- The contract stipulates the PPP-company's use of construction companies. A portion of the responsibilities is transferred to the executing construction company in separate contracts.
- The PPP company will build the project, and then operate and maintain it for 25 years.
- The finance plan needs to be approved, together with all underlying loans, lender, payment time and interest rates. In the finance plan there will also be a model portraying income and expense numbers for each year in the contract period. The offer also contains requirements for insurance.
- The payment model contains the following:
    - Payment for availability
    - Payment for operational standard
    - Payment for traffic load above stipulated prognoses
    - Payment for road safety above comparable road stretches

4.1.1 Payment mechanism

The monthly payments comprises of five elements.

- BTM Payment for traffic load above prognosis
- BS Bonus for road safety (max. 1-2 mill.)
- BD Payment for operational standard (10-20%)
- BT Payments for an open and available road (80-90%)

Figure 17 Payment mechanism

- TBB Early payment for parts of the building costs(After the first payment period the three first years)

$$TB_y = BT_y + BD_y + BTM_y + BS_y + TBB_y$$

The BT and BD are payments post-paid every month, whilst possible BTM and BS payments are post-paid yearly, and the TBB element is included the first three years.
As can be seen, BT is by far the biggest part of the payment. This portion is influenced by the availability of the road. If the road or sections of it are closed, the NPRA reduces the payment, according to the contract. The same goes for operational standard, deduction points are given if the reported problem is not fixed within the time limit stipulated in the contract for the specific type of error/deviation from standards.

For all the three PPP roads, the NPRA has three employees that are responsible for controlling their respective roads. They check if the road is available and check the operation standard. The PPP contract has a very detailed portion where different demands and criteria is listed, with accompanying point for a scoring system. This system shown in table 7 is put into place so if the company gets from 1-10 point, they get a fine for each point with one certain value, from 11-20 the value is doubled, the same from 21-30, and over 31 the value is doubled and stable onwards. The NPRA were not willing to share the weighting of these criteria, nor the value of the deduction points.

The different deduction criteria are all listed in Attachment 3, and the contract terms are shown in attachment 4.

Table 7 Deduction point interval model

	Nedre grense	Øvre grense	Verdi per Trekkpoeng
1. Intervall	0	10	
2. Intervall	11	20	
3. Intervall	21	30	
4. Intervall	31	Ingen	

In 2013, OPS III E39 Klett- Bårdshaug will receive payments totalling 165 million NOK. 100 million are from the toll roads, and the remaining 65 million from the government through the national budget (Hindklev, 2013). In figure 18, three different payment models that were considered are listed.

The PPP company sends a status report each moth containing incidents, availability etc. Following up this report there is a meeting where the NPRA and the PPP company discussed deduction points and availability. Following this meeting, an invoice is sent from the PPP company to the NPRA. Together with the close inspection by the NPRA representative, there is an annual inspection of the road, and a main inspection done every fifth year.

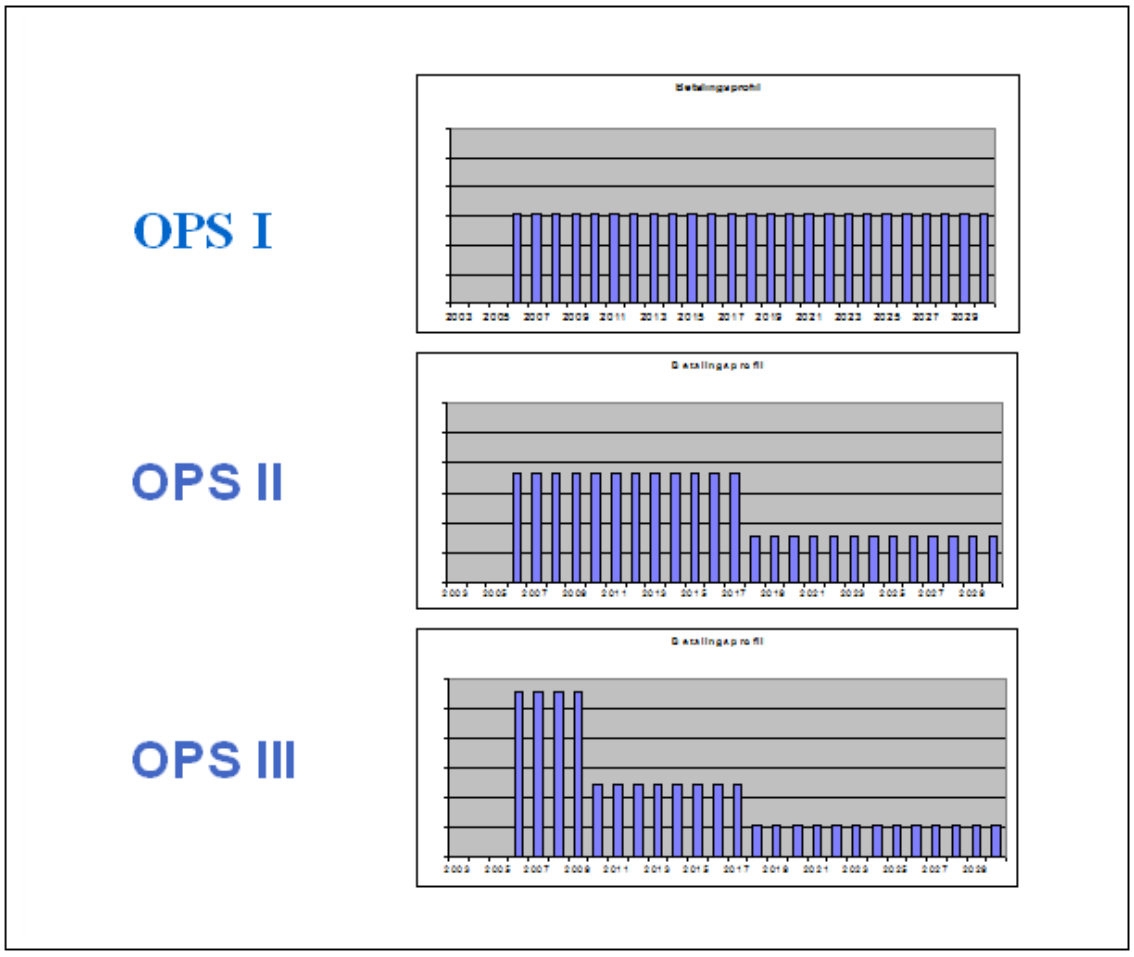


Figure 18 Payment models

4.1.1.1 Contract price

In table 8, the thee PPP projects are listed with the price, what the price would have been as a traditional project, with accompanying empirical figures. For E39 Klett – Bårdshaug, the estimated price when it was in the NTP 2002-2011 was between 1-1,2 Billion NOK (Samferdelsdepartementet, 2001).

Table 8 Key figures PPP (Eriksen. et al., 2007)

	Prisnivå	Erfaringstall	Tradisjonell gjennomføring (St.prp)	Beregnet total OPS prosjektkostnad
Klett - Bårdshaug	2004	1 450	1 381	1 540
Lyngdal - Flekkefjord	2005	1 350	1 193	1 400
Grimstad - Kristiansand	2008	3 900	3 475	3 550

Below, in figure 19, the project can see a model for the finances for the projects. One can see the development of loan payments, how big a portion is interest rates etc.

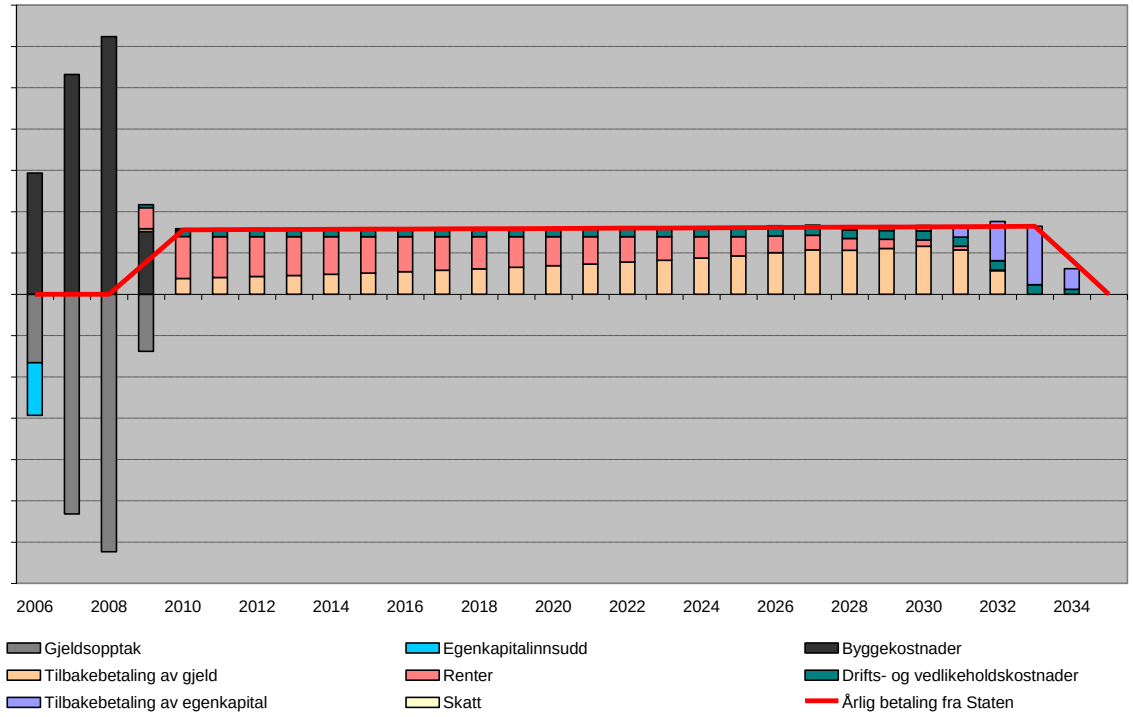


Figure 19 Finance Chart for Orkdalsvegen

4.1.1.2 Construction time

The time it took to build the roads was in all three cases substantially shorter than what the prognosis was for the same projects under normal enterprise contracts. Figure 20 illustrates the difference in construction time. This was something the NPRA had not foreseen (Hindklev, 2013), and there are several factors mentioned as the possible reason for this. More involvement and responsibility in parts of the front-end of the project, resulting in the possibility for the contractor to start building the parts that had the longest completing time whilst they still were doing the detailed planning on other parts. Standardised solutions for tunnels and bridges, one big parcel instead of several small ones, payments

first start when the road is operational. The financial aspects with no payments from the public until opening is regarded as important. These are all plausible contributing factors.

Prosjekt	Faktisk byggetid i prosent av byggetid for tradisjonell gjennomføring (Anslag)	
E39 Klett - Bårdshaug		
Tradisjonell (Anslag)	42 mnd	100 %
Faktisk	27 mnd	64 %
E39 Lyngdal - Flekkefjord		
Tradisjonell (Anslag)	54 mnd	100 %
Faktisk	28 mnd	52 %
E18 Grimstad - Kristiansand		
Tradisjonell (Anslag)	60 mnd	100 %
Faktisk	38 mnd	65 %

Figure 20 Construction time

4.1.2 E39 Lyngdal – Flekkefjord and E18 Grimstad – Kristiansand

Since E39 Klett – Bårdshaug is the stretch that will be used for the financial comparison; the two other projects will be used in the other parts of the investigation, and will therefore not be explained in such detail. As described earlier, both projects are financed by private banks, and both NIB and EIB. They also both have a flat payment model like OPS I in figure 18.

4.1.2.1 E39 Lyngdal – Flekkefjord

This is the smallest of the three PPP project in terms of budget. The prognosis for the construction time was longer than for the other E39 projects, but the actual building time was just one month longer. Resulting in it being close to half the prognosis for construction time. For this project, there were three main construction companies, Veidekke, Kruse Smith and Brødrene Reme. Veidekke is the construction company responsible for the maintenance.

Figure 21 E39 Lyngdal-Flekkefjord

4.1.2.2 E18 Grimstad – Kristiansand

This is the longest and most complex of the three PPP projects. The cost is at 3,3 billion NOK, and the building time was 38 months. The contractor had a substantial cost overrun, approx. 1.2 billion NOK (Allfarveg, 2014). The private contractor has to cover tis cost overrun itself, since they have no claim on any compensation from the NPRA. The tables and details earlier in this chapter cover other details surrounding this project. The main construction company was an organised joint venture between Bilfinger Berger and Pihl & Søn. For the maintenance, there are many construction companies involved, NCC Roads and Otera being two of them. The PPP company is named Allfarveg.

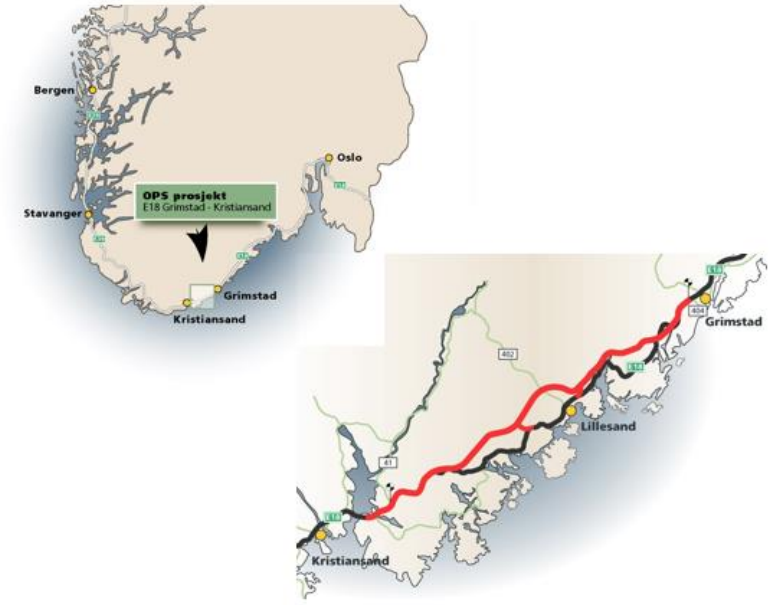


Figure 22 E18 Grimstad-Kristiansand

4.1.3 E39 Klett- Bårdshaug

The PPP project that will be further investigated is the road stretch E39 Klett- Bårdshaug.

The PPP company Orkdalsvegen used the construction company Skanska Norge as the contractor responsible for the building of the road. One of the theories surrounding PPP is that with the full responsibility that comes with both building and maintaining the road for 25-years, is that this results in a bigger focus on LCC. In the case of Orkdalsvegen, Skanska decided to build the foundation 30 cm thicker than what the regulations say is necessary, resulting in a stronger and stiffer road. In areas with clay pruned to landslides in periods of heavy rain, they put in extra rocks preventing this. One of the tunnels were built 160meters longer, due to possible problems with clay areas. There are many other both small and large improvements and or changes from the original plan that have been made to increase the reliability and life of the road and related facilities. These changes were done without any extra charge to NPRA (Hindklev, 2013).

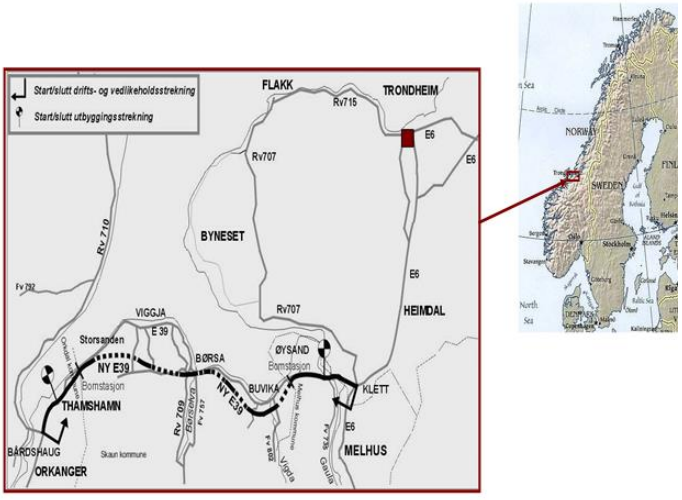


Figure 23 Location and lay of E39 Klett- Bårdshaug (Horvli, 2013)

The original Owners of the PPP company Orkdalsvegen were Skanska ID and British Laning Roads. The owners now are the pension investment funds of Skanska Norway and Sweden (Hindklev, 2013).

As described earlier, the payment plan for this project is in some ways similar to what Lasse Fridstrøm at TØI suggests as a god solution. The payments are biggest the first three years, and in 2018, the toll roads will close, and the payments will decrease to the lowest level, which will be at that level the last years of the contact.

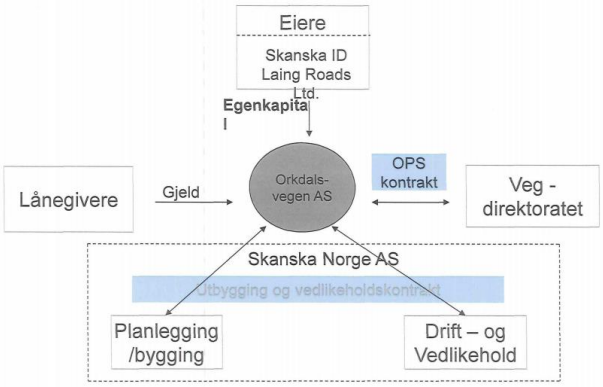


Figure 24 Contract structure Orkdalsvegen (Hanssen, 2008)

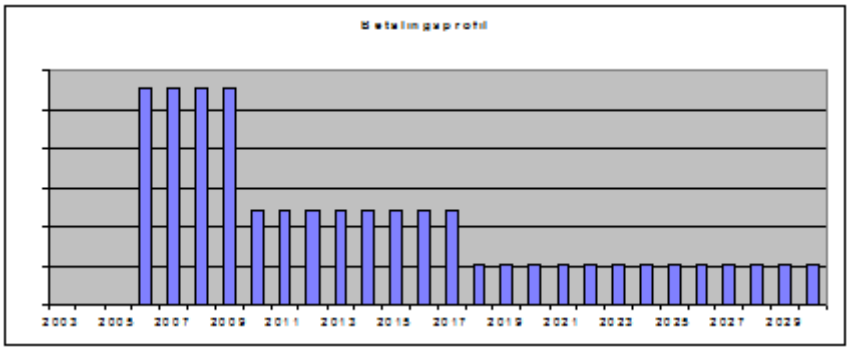


Figure 25 Payment profile (Horvli, 2013)

The traffic prognosis for E39 Klett – Bårdshaug in table 9 is part of the payment portion of the contract. It is this prognosis that is the basis for the BTM, payment for traffic load above prognosis. This payment is activated if the traffic exceeds the prognosis by 20%.

Table 9 Traffic prognosis E39 Klett – Bårdshaug (vegvesen and Vegdirektoratet)

År	Trafikkprognose (ÅDT)		År	Trafikkprognose (ÅDT)
2005	6 904		2018	9 047
2006	6 847		2019	9 245
2007	7 019		2020	9 447
2008	7 196		2021	9 608
2009	7 377		2022	9 772
2010	7 563		2023	9 938
2011	7 738		2024	10 108
2012	7 917		2025	10 280
2013	8 101		2026	10 453
2014	8 288		2027	10 628
2015	8 480		2028	10 807
2016	8 665		2029	10 989
2017	8 854		2030	11 173

4.2 QUESTIONNAIRE

Regarding the questionnaire, it was sent to persons responsible for maintenance contracts in the NPRA. It was also sent to construction companies responsible for the maintenance and operation. The same regarding the three PPP projects. The questionnaire had fourteen respondents, where one did not give real answer due to a negative attitude towards the questions. This particular respondent's answers are therefore not be taken into consideration. The questionnaire was sent to twenty persons, all representatives from either the NPRA, contractors or PPP companies. Of the thirteen responses, ten were from the NPRA, and three from construction companies and PPP companies, eight were from a traditional contract and four from a PPP contract.

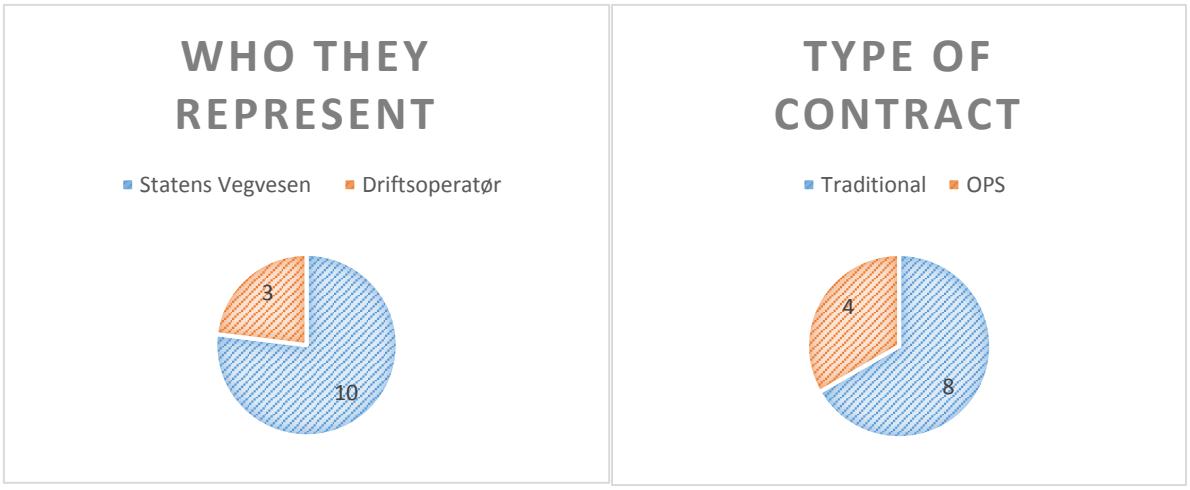


Figure 26 Who did the respondents represent and what type of contract

The large portion of NPRA respondents compared to contractor is due to the lack of willingness from the representatives of the NPRA to share information on the contractors hired in their projects. Given this lack of database, the questionnaire dos not give the desired reliability in form of a stable database. It does however give pointers in some questions, and a good basis for questions in the interviews conducted.

The questionnaire had 10 questions in Norwegian, where the intention of the three first are to map who the person is representing and what type of contract it is he is handling. The questions are translated into English, with the text in appendix 1.

Question 1-3:
The answering options are for the first the NPRA or a contractor. For the second it is PPP contract or regular operation and maintenance contract. The third is what region of Norway the contract is.

Question 4:
"If you would have been responsible for the project planning and building of the road stretch you are responsible for. To what extend would you have made changes to enhance the total quality and reduce the need for maintenance?"
The answering possibility was a scale 1-10, where 1= to no or little extent 10 = to a large extent

The aim with this question is to find out whether there is a consensus that maintenance cost reducing measures are better planned within PPP because the constructor and operator are the same.

Result: As figure 27 shows, there are similar results between TP and PPP contracts, and NPRA and private representatives. Respondent 6, 10 and 13 are representatives from construction company, the

rest from the NPRA.

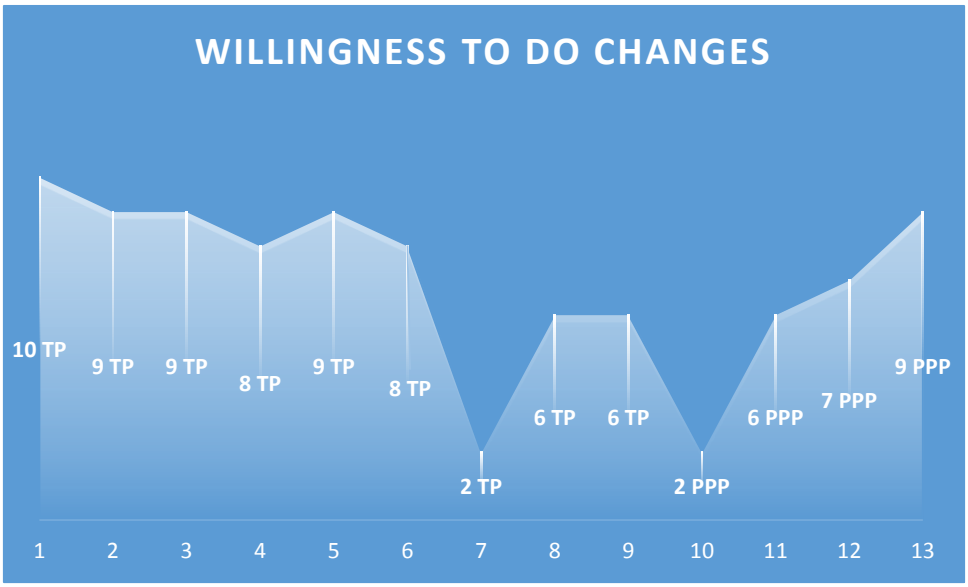


Figure 27 Graph showing the willingness to do changes

Average Construction company: 6.33
Average NPRA: 7.2
Average TP: 7.4
Average PPP: 6

NB! One of the PPP representatives gave this measure a low score. It is believed the cause of this is because they in these projects have made changes on this measure.

Question 5:
"Would it be better with shorter or longer lasting maintenance contracts compared with today's length?"
The answering possibility being 1-10, where 1=Shorter, 5=Good today and 10=Longer.

This question is aimed at finding out if there is a consensus on this. This area is quite different from PPP to TP contracts.

Result: As figure 28 shows, there are differences in opinion between PPP contracts and TP, but the results for NPRA and construction company representatives are more similar. Respondent 6, 10 and 13 are representatives from construction company, the rest from the NPRA.

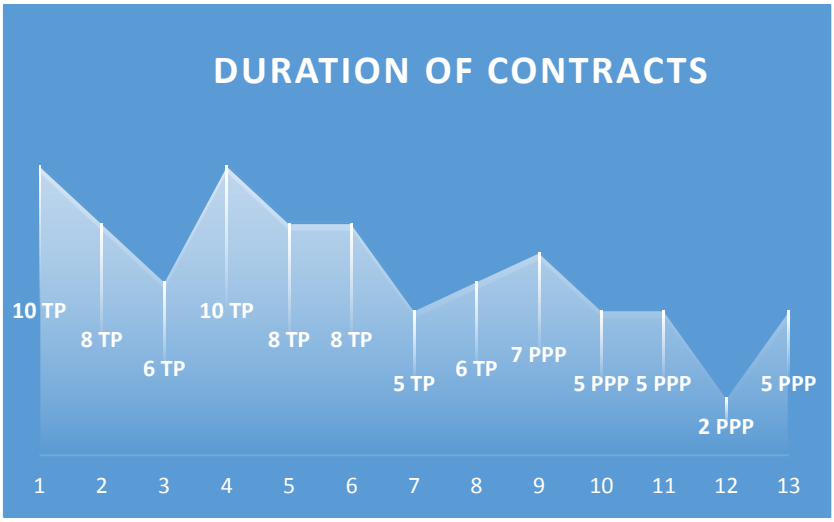


Figure 28 Graph showing the desired duration of contracts

Average Construction company: 6
Average NPRA: 6.7
Average TP: 6.77
Average PPP: 4.25

Question 6:
"What is the amount of supervision perceived to be?"
The answering possibility being 1-10, where 1=seldom and 10=often.

The amount of perceived supervision from SVV is not the same as the factual amount. It can give an indication if the amount should be higher, connected with the next question.

Result: As figure 29 shows, there are differences in opinion between PPP contracts and TP, but the results for NPRA and construction company representatives are more similar. Respondent 6, 10 and 13 are representatives from construction company, the rest from the NPRA.

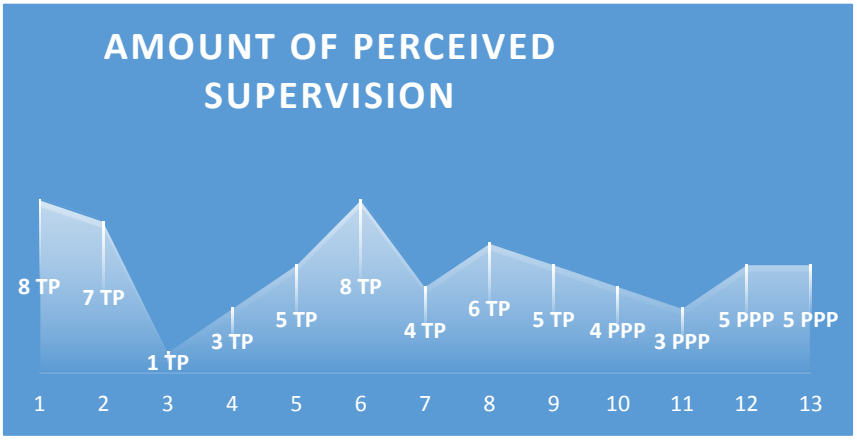


Figure 29 Graph showing the amount of perceived supervision

Average Construction company: 5.66
Average NPRA: 5.7
Average TP: 5.22
Average PPP: 4.25

Question 7:
"To what extent would the quality of the maintenance increase with closer supervision and stronger sanctions?"
The answering possibility being 1-10, where 1=no change and 10=big change

The aim of the questions is to identify differences in supervision between PPP and TP.

Result: As figure 30 shows, there are differences in opinion between PPP contracts and TP, but the results for NPRA and construction company representatives are more similar. Respondent 6, 10 and 13 are representatives from construction company, the rest from the NPRA.

Figure 30 Graph showing thoughts about increased quality with more supervision

Average Construction company: 3
Average NPRA: 6.5
Average TP: 6.22
Average PPP: 4.5

Question 8 and 9:
8. "What is the length of the road under your supervision?"
9. "Does this length give the best utilization your time and equipment?"

The answering possibility being three options. Too short, good or too long.

The aim was to find out what the variation in the length of roads, and what is perceived as ideal kilometre amount of road in a maintenance contract.

Question 10:

"Do you have any other thoughts around possible elements that could rise the quality of the service delivered to the road users on your road?"
The answering possibility here is an open text box for comments and thoughts.

4.3 COLLECTION OF MAINTENANCE COSTS.

For maintenance and operation of roads there is, through reports from the NPRA, collected a substantial amount of data. These data are collected in order to show which costs that contribute to the expenses in operation and maintenance of the roads. The data might vary, but an attempt is made at identifying what suits this road sector the best. The purpose is to identify which costs comes from operation and maintenance, as well as trying to see whether the operators of the PPP projects has done anything in particular to try to reduce or optimize these costs. The ViaNova report delivered in 2014 is a report covering maintenance and operation of roads in the central region of the NPRA. Thus, the data is very reliable and valid for the area covered in the project as well. The report is comprehensive and includes much more data than could have been included in the analysis performed in this project.

Figure 31 Maintenance contracts in central region of the NPRA. Contracts covering the Trondheim area are highlighted in the red circle (Vegvesen, 2012b).

Regarding general costs of operation and maintenance it is very hard, if not impossible, to obtain actual tender sums for a specified road sector, such as the reference sectors which were presented in the problem statement. The reason for this is that all operation and maintenance contracts in a region is also sorted in regions. This implies that the contract covering for example E6 east, Trondheim-Stjørdal, is implemented in the contract 1606 Trondheim-Malvik (approx. 440 km road)(Vegvesen, 2009) and 1706 Stjørdal (approx. 713 km road)(Vegvesen, 2014c). These contracts include all roads owned by the NPRA in the area around Trondheim (see figure 31), with exception of the E39 Klett-Bårdshaug which is a PPP contract. In the latest competition for the contract, the bid that won the 1606 Trondheim contract was at 145 million kroner, and the 1706 contract for Stjørdal was at 203,4 million kroner. Both contracts with a five-year duration and the price is for the whole period. Thus, it is not possible to bring out an actual tender sum for a specified road sector. Because of that, the sum regarding operation and maintenance will be carried out with help of the report made by ViaNova. The report is described in the methodology chapter, and numbers equalling the E39 is used in order to carry out a hypothetical maintenance cost for the sector. Basis for all calculations presented in the chapter, can be found in attachment 5, *"calculations of maintenance costs for the project."*

Facts about the road sector is shown in table 10.

Table 10, Road data PPP Klett-Bårdshaug

Road data for the PPP stretch Klett-Bårdshaug:		
Total meters (approx.)	26839	100 %
Total meters tunnel (approx.)	10740	40 %
Total meters bridge (approx.)	845	3 %
Total meters road in the day (approx.)	15254	57 %

4.4 TRAFFIC MEASUREMENTS AT THE E39 KLETT-BÅRDSHAUG

To find out how many vehicles used as a basis for calculations, the contract state that "the average of three measuring points along the route gives the prognosis of which points to count"(Orkdalsvegen and Vegvesen, 2003). The three measuring points used for calculations, are the Brekktunnelen (5,2 km from Klett), the Mansfjelltunnelen (10,4 km) and the Storsandtunnelen (20,3 km). To measure the traffic volumes along the road, the public sources available are used, including road maps and traffic measurement data available from the NPRA on the internet. The deep red background color indicates that the numbers are not included in the calculations.

Table 11, Traffic calculations for Klett-Bårdshaug

	Measuring point	Øysand	Brekktunnelen	Mansfjelltu-nnelen	Storsand	Total		
	Meter from Klett roundabout	2898	5188	10388	20268			
	Traffic prognosis E39, from contract.						Extra payment?	prognosis + 20 %
2005	6904	9705	8251	7894	6313	7486	no	8285
2006	6847	9894	8455	7888	6428	7590	no	8216
2007	7019	10398	8994	8508	6821	8108	no	8423
2008	7196	10986	9306	8648	7029	8328	no	8635
2009	7377	10834	9392	8745	7151	8429	no	8852
2010	7563	10885	9275	8774	7176	8408	no	9076
2011	7738	10935	9538	8989	7507	8678	no	9286
2012	7917	11086	9692	9167	7599	8819	no	9500
2013	8101	11689	10017	9426	7678	9040	no	9721
2014	8288	11916	10265	9616	7869	9250	no	9946
2015	8480	12148	10519	9810	8066	9465	no	10176
2016	8665	12385	10779	10007	8267	9685	no	10398
2017	8854	12626	11046	10209	8473	9909	no	10625
2018	9047	12872	11320	10415	8684	10140	no	10856
2019	9245	13122	11600	10625	8901	10375	no	11094
2020	9447	13377	11887	10839	9123	10616	no	11336
2021	9608	13638	12181	11057	9350	10863	no	11530
2022	9772	13903	12483	11280	9583	11115	no	11726
2023	9938	14174	12792	11508	9822	11374	no	11926
2024	10108	14449	13108	11740	10067	11638	no	12130
2025	10280	14731	13433	11976	10318	11909	no	12336
2026	10453	15017	13765	12218	10575	12186	no	12544
2027	10628	15310	14106	12464	10839	12470	no	12754
2028	10807	15608	14455	12715	11109	12760	no	12968
2029	10989	15911	14813	12971	11386	13057	no	13187
2030	11173	16221	15179	13233	11670	13361	no	13408
						extra pay?	0	of the years
	measured by the NPRA							
	own calculated prognosis							
	PPP contract forecast							

The forecasts measures that the traffic, with a little higher increase than the forecasted average of today, probably will exceed the "extra payment value" towards the end of the contract period. However, the traffic must increase more than 2 % each year to reach the extra payment value, which not is corresponding with the forecasted value in NTP, which is set to be around 1,5 % (Samferdelsdepartementet, 2003-2004) .

4.5 CALCULATION OF TOTAL MAINTENANCE COSTS OVER THE WHOLE OPERATION PERIOD FOR THE PPP PROJECT KLETT-BÅRDSHAUG

4.5.1 Tunnels

The report "Moderne vegtunneler", "Modern road tunnels", analysis from 2012, identifies that a tunnel with a yearly average daily traffic of about 10000 costs somewhere between 800 000 – 1 000 000 NOK per kilometre per year (Vegvesen, 2012). The report has also made a linear function made on basis of the average cost of all oversea one-tube tunnels, showing the increase of costs as traffic increases. The function is used in order to calculate the maintenance costs each year for the tunnel part. The function used is reliable and is presented in figure 32.

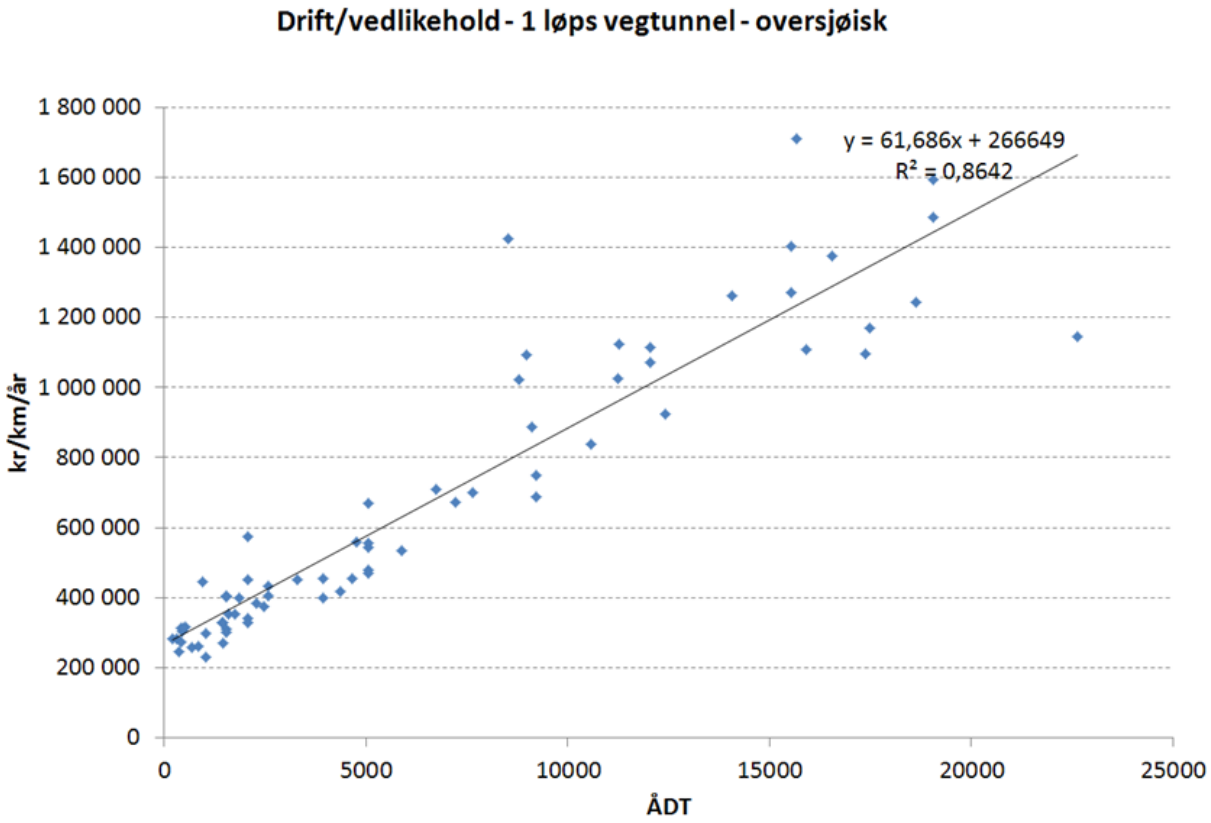


Figure 32 Regression line showing how the maintenance costs of a tunnel increases as function of YDT (Vegvesen, 2012).

4.5.2 Bridges

The maintenance cost for bridges are based on the value of earlier data captured by the NPRA and calculations made by ViaNova based on the numbers delivered. The cost for bridges, independent from YDT and speed limit, is set to be 209 kr/m^2, which has been tested to most bridges in the region and prove as a good value. Thus, that cost is applied to the calculations of the maintenance costs for

the whole sector. The road sector is built with a road width at 10 meters, with some sectors at 13 meters width. (3,5 meters width at the one lane sector, 3,25 meters width in the two lane, as well as 1,5 meter shoulders). The Hammersbrua and Saltnesbrua in Buvik has three lanes (2+1) over its whole length, as well as an exit way towards the end of one of the sides, which makes part of the road a 3,5 lane. Calculations are here entered with a 16,25 m width for 30 meter of each of the bridges. One of the bridges is probably longer than 30 meters and the other probably below, but the average of them is somewhere close to 30 meters. Rossvollbrua in Børsa has three lanes (2+1) over its whole length. The Kallfossbrua is a two-lane bridge with a width of 10 meters over the whole length.

4.5.3 Road in the day

Regarding road in the day, the maintenance report by ViaNova, has done the same calculations, with a differentiation between different road types. For calculations, the costs they calculate for road type H4, H5, H6 is used. This road type corresponds to a road with an YDT of between 4000 and 20000, with a speed limit between 60-90 km/h. The average of these roads in central region is around the traffic volume at Klett-Bårdshaug. The data collected for these roads is also very reliable when you look at the regression line that is showing the average of the roads, as shown in the figure 33. Due to uncertainty regarding differences in cost for three lanes compared to two, such a difference in not taken into account in the maintenance cost calculations.

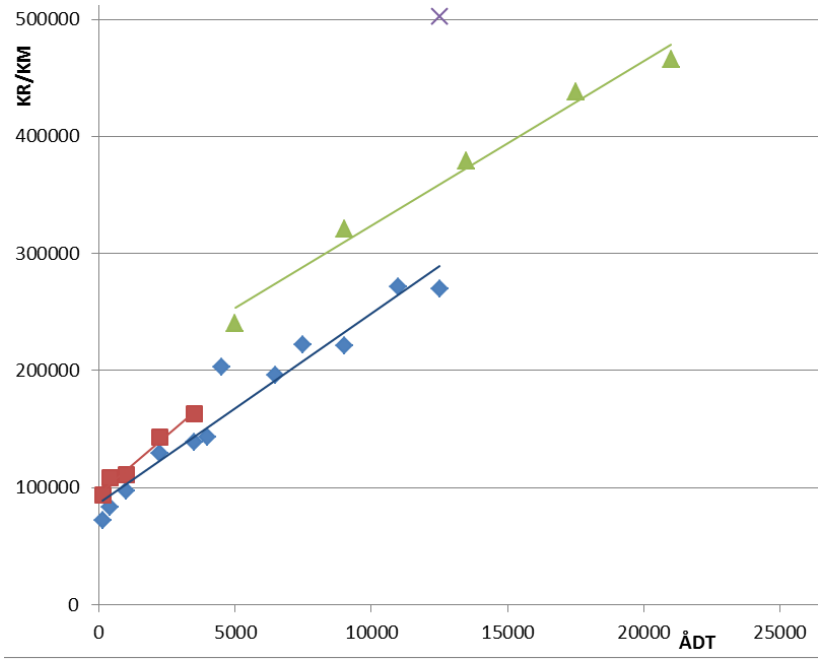


Figure 33, The Green line indicates maintenance costs for the road type used in the calculation. The data are within an acceptable range of the regression line (ViaNova, 2014).

4.5.4 Model development

The model calculating the maintenance costs is very advanced, including several variables. It includes adjusted value for the krone; all values are of 2013 kroner. Traffic volume for the different sections of the road are taken into account. As well is the difference in maintenance value for tunnels, bridges (including different width) and road in the day. The traffic volumes are adjusted for expected growth over the years. The values is used to show where the maintenance costs comes from, both with emphasis on which road element, and which road sector is most cost consuming. As mentioned earlier, all basis data come from the report “moderne vegtunneler” report and the maintenance and operation report for the central region of the NPRA, made by ViaNova. All numbers are conceptual, and made on the basis from the explanation above.

4.5.5 Presentation of maintenance costs

It is important to remember that the costs calculated from this report refers to the costs that the NPRA has as historical figures. This implies that the costs calculated for the Klett-Bårdshaug sector is not representing the cost picture for the PPP company. However, it can be utilized as reference for maintenance costs for the PPP company, by for example, prove useful as a benchmark. Because there are no possibilities to find factual costs for a reference sector to use, it is supposed to be very useful to calculate the hypothetical costs for maintenance for this road specifically. Then it is possible to present what differences the two types of road owners in the analysis chapter. In this case, especially regarding the extra costs Orkdalsvegen has selected to take in the construction phase in order to optimize the LCC for the whole project.

4.5.6 Short presentation of the different sectors of the road:

4.5.6.1 Klett-Øysand

The sector between Klett and Øysand represent 17 % of the total length of the road. It consists of road in the day only, and a part of the road is upgraded from old existing road from the PPP company prior to opening.

Table 12, Calculated maintenance costs for Klett-Øysand

Klett -	Øysand	Maintenance cost for the stretch (discounted 2013 kr)				
		tunnel	Road	bridge 10	bridge 13	bridge 16,25
time period		0	4306	0	205	0
2005	2010	kr -	kr 10 265 638	kr -	kr 3 873 295	kr -
2011	2016	kr -	kr 9 150 063	kr -	kr 3 278 408	kr -
2017	2022	kr -	kr 7 503 793	kr -	kr 2 517 475	kr -
2023	2028	kr -	kr 6 137 834	kr -	kr 1 933 159	kr -
2027	2030	kr -	kr 1 350 457	kr -	kr 407 188	kr -
			total:	kr 46 417 311		
			% of total:	13 %		

4.5.6.2 Øysand-Buvik

The sector Øysand-Buvik represent 11 % of the total road sector and consist of all road elements.

Table 13, Calculated maintenance costs for Øysand-Buvik

Øysand-	Buvik	Maintenance cost for the stretch (discounted 2013 kr)				
		tunnel	Road	bridge 10	bridge 13	bridge 16,25
time period		1440	1402	0	180	30
2005	2010	kr 8 180 219	kr 3 117 206	kr -	kr 3 400 942	kr 719 430
2011	2016	kr 7 514 996	kr 2 782 506	kr -	kr 2 878 602	kr 608 935
2017	2022	kr 6 411 947	kr 2 292 937	kr -	kr 2 210 466	kr 467 599
2023	2028	kr 5 501 949	kr 1 901 653	kr -	kr 1 697 408	kr 359 067
2027	2030	kr 1 248 098	kr 422 291	kr -	kr 357 531	kr 75 632
			total:	kr 52 149 413		
			% of total:	15 %		

4.5.6.3 Buvik-Børsa

The road sector Buvik-Børsa also consist of all road elements, and 24 % of the total road sector.

Table 14, Calculated maintenance costs for Buvik-Børsa

Buvik-	Børsa	Maintenance cost for the stretch (discounted 2013 kr)				
		tunnel	Road	bridge 10	bridge 13	bridge 16,25
time period		2870	3155	0	260	30
2005	2010	kr 15 634 378	kr 6 830 674	kr -	kr 4 912 472	kr 719 430
2011	2016	kr 14 339 349	kr 6 085 955	kr -	kr 4 157 981	kr 608 935
2017	2022	kr 12 000 399	kr 4 945 586	kr -	kr 3 192 896	kr 467 599
2023	2028	kr 10 051 697	kr 4 027 904	kr -	kr 2 451 811	kr 359 067
2027	2030	kr 2 241 621	kr 882 640	kr -	kr 516 434	kr 75 632
			total:	kr 94 502 458		
			% of total:	27 %		

4.5.6.4 Børsa-Bårdshaug

The Børsa-Bårdshaug sector also consist of all road elements. The sector is the only sector with a two lane, 10 meter wide bridge. 48 % of the PPP contract is in this sector. The last part of the road is upgraded from existing road.

Table 15, Calculated maintenance costs for Børsa-Bårdshaug

Børsa-	Bårdshaug	Maintenance cost for the stretch (discounted 2013 kr)				
		tunnel	Road	bridge 10	bridge 13	bridge 16,25
time period		6430	6391	140	0	0
2005	2010	kr 30 698 838	kr 12 759 800	kr 2 034 752	kr -	kr -
2011	2016	kr 28 179 968	kr 11 346 410	kr 1 722 240	kr -	kr -
2017	2022	kr 23 773 150	kr 9 243 735	kr 1 322 501	kr -	kr -
2023	2028	kr 20 245 010	kr 7 593 234	kr 1 015 543	kr -	kr -
2027	2030	kr 4 558 220	kr 1 672 518	kr 213 907	kr -	kr -
			total:	kr 156 379 828		
			% of total:	45 %		

4.5.7 Maintenance cost per road element.

When planning a road sector, the importance of having the maintenance cost in mind for different road elements is important. Not only the construction itself need to be analysed, but also the cost of maintaining the elements after completion, in other words during operation. This table present the maintenance cost contribution to the different road elements in the contract.

Table 16, Maintenance cost comparison for different road elements

Road data for the PPP stretch Klett-Bårdshaug:			Cost per element	% of maintenance costs
Total meters (approx.)	26839	100 %	kr 349 449 010	100 %
Total meters tunnel (approx.)	10740	40 %	kr 190 579 840	55 %
Total meters bridge (approx.)	845	3 %	kr 48 556 335	14 %
Total meters road in the day (approx.)	15254	57 %	kr 110 312 835	32 %

From the table there can be seen that the tunnels and bridges are standing for a high proportion of the maintenance costs, compared to relative length of the element.

4.5.8 Additional maintenance costs.

In addition to the costs presented above, there are fixed costs for road elements that is depending on other variables used in the calculations above, according to the report. The costs has not been implemented in the models, because it has been difficult to obtain factual values of the elements. These costs is neither seen as a point where there are possibilities of large savings, because the output is relatively standardised. However, it is important to include the costs in comprehensive calculations, because the costs will be added to the final budget. The table below describes the costs and possible variation for the different elements.

Table 17 Costs for additional road elements, including variation (ViaNova, 2014)

Object [unit]	Annuity cost	Variation	Variation reason
Brick Wall [m]	19,70 kr/m	5-50 kr/m	Height, units per area.
Noise barrier [m]	171 kr/m	60-350 kr/m	Material, height
Shelter [pcs]	15 400 kr/pcs	13 500-17 500 kr/pcs	Material, winter conditions
Rock cutting and restraint [m2]	36,60 kr/m2	15-60 kr/ m2	Height, securing type
Railings [m]	9,60 kr/m	7-20 kr/m	Type of railing, type of ending, as well as number of endpoints
Cushions [pcs]	946 kr/pcs	650-1650 kr/pcs	Type
Fence [m]	28,00 kr/m	13-65 kr/m	Type
Signalling [pcs]	48 000 kr/pc	20 000-85 000 kr/pc	Amount, type and YDT
CCTV [pc]	9660 kr/pc	6000-23 000 kr/pc	Life time of the camera
Road Lighting [km] (Cost applies at one sided road lighting)	52 600 kr/km	42 000-62 000 kr/km	YDT and speed limit
Main Picnic [pcs] (Cost includes cleaning, buildings and equipment, provided toilet connected to the public network)	359 000 kr/pc	250 000-810 000 kr/pc	Opening times, amount and equipment type
Small / medium sized picnic [pc] (Cost includes cleaning, buildings and equipment)	49 500 kr/pcs	30 000-315 000 kr/pcs	Opening times, amount and equipment type
Grassland Area [m2]	6,21 kr/m2	1-8 kr/ m2	Average temperature during summer months
Shrub Area [m2]	25,90 kr/m2	13-40 kr/ m2	Climate and type of shrubs
Trees [pcs]	194 kr/pc	95-300 kr/pc	Climate and type of tree
Flower Fields [m2]	116 kr/m2	55-240 kr/ m2	Level of ambition for the area, climate
Curb stone [m]	1,81 kr/m	1,50-4 kr/m	Placement, YDT and speed limit
Pavement [m]	75,40 kr/m	70-95 kr/m	Width and winter conditions

4.6 INTERVIEWS

Interviews with key persons in the three PPP companies and the NPRA have been held, where the questions are based on the theory gathered and from the responses in the questionnaire. The responses from these interviews that were relevant are imbedded and analysed in the analysis chapter. The interview guide is described in attachment 1.

4.6.1 Central findings

From the interviews, some aspects are especially interesting for this thesis. Central citations and findings are presented below.

4.6.1.1 Building time

All three PPP company representatives mentioned several measures implemented with a goal of reduced maintenance costs and lower LCC.
Both interviewee 1 and 2 mentioned the free or self-financing of the building, the construction companies own planning freedom as elements that reduced construction time. Interviewee 1,2 and 3 mentioned the size of the project with the possibility of several points of attack for the construction as a significant construction time reducing factor. Interviewee 1 also mentioned the possibility of parallel planning as a contributing factor, and pointed out that this was something contractors were not able to do in traditional projects for the NPRA.

Interviewee 3 gave an illustrative example when it comes to the benefits of one large project. He mentioned the last part of E18 in Vestfold County, which is run as a traditional project. The total length of highway is about the same length as the PPP project E18 Kristiansand- Grimstad. The TP project was split into three project enterprises, whilst the PPP road is organised as one. At the PPP project, it is big enough for the contractors and all the involved parties so that they can fully use the resources at their disposal.

4.6.1.2 Cost of bid

The bid process for the PPP projects is an element that interviewee1 has an interesting view on. It is his opinion that the bid process was too expensive. He argued that the need for so many rounds was ineffective in his mind. In a case where similar PPP projects are announced, he would like this process to not involve so many rounds, and would have the selection done earlier in the process.

Interviewee 2 said that since the process is so big and financially demanding, it is crucial that more than one PPP project is put forward in the same period. It is easier for the firms to take a chance on using resources at a bid if there is a market for these types of projects. He admits that if there would have only been one PPP project put forward instead of the three trial projects, he doubts that his firm would have taken a chance on competing for the contract. He also mentions that since this is the first time they entered a bid for a PPP project, they had to "learn" this type of contract, which is not the case for an eventual new round with PPP projects, in turn lowering the cost to some extent.

Interviewee 3 says that the bidding process combined with the financial model that is used in these projects are the two drawbacks with PPP projects in is mind. The bidding process is comprehensive, and involves many parties. The use of advisors and consultants throughout the process is a big expense, and the number of contracts needed with different parties is vast. These contracts are also a strength he mentions, since there is little room for misunderstandings and conflicts when these contracts are in place.

Interviewee 3 says that the foreign contractor hade several solutions they had good experiences with in their county that they wanted to implement which the NPRA had no knowledge about. The process of getting these solutions approved by the NPRA turned out to be a "bureaucratic nightmare" resulting in the contractor giving up in trying to implement unknown solutions with NPRA eyes, and sticking to the road manuals.

4.6.1.3 Improvements on quality and standardising

From the PPP companies it is told there were made considerable savings due to the standardising of elements. Since the projects were large and contained several bridges, which is an element that contains many components that are easily standardised. Portals for tunnels are one example of an element that can be standardised. The fact that the NPRA does not make more use of the advantages of standardising than they are doing today is mentioned. A simple thing that can illustrate this is pedestrian bridges over roads, mentioned by interviewee 4. Now there probably are around a hundred different bridges to choose from.

Interviewee 3 mentioned that during the planning phase of the project, the PPP company involved the maintenance and operation personnel in the design process. This was done in order to take advantage of these people's experience and knowledge when it comes to measures that could be of use in the reduction of maintenance costs. He specified that there was a focus on LCC under the planning and designing of the road. The focus on LCC is also one of the reasons the operation and maintenance personnel was involved in this process. The motivation of course largely being the potential for saving money on this budget cost.

The different measures implemented by the different companies are presented in the analysis.

4.6.1.4 Change orders

According to interviewee 1,2 and 3, change orders have already happened. They have not experienced any problems agreeing with the NPRA about the parameters and compensation for these changes. Interviewee 2 says that it is up to the NPRA to deem which changes are necessary and which are not.

4.6.1.5 Road development contract, an attempt at implementing elements of PPP into TP

Incentives such as the construction companies own gain in having expensive machinery at the site for a short time ass possible is one of the issues that is mentioned by interviewee 4, which can lead to shorter building time. He points out that in the road development contract, the possibility of starting construction whilst some planning is still going on is not an option.

Interviewee 4 gave an example of if the construction mean time is set to 3,5 years. The company will get a bonus if it is from 3 till 3,5years, but no bonus for completion earlier than that.
He mentioned an interesting aspect regarding this. He emphasised that there is a breaking point for the reduction in construction time, and that there should be a realistic estimate, so that the reduction of construction time does not lead to a reduced focus on the health and safety of the workers, the breaking of the work environment act and the quality of the solutions.

One of the elements mentioned in the interview by interviewee 4 was the selection criteria in the contract. Many of the TP contracts only or mainly have a focus on cost. This is not the case for the road development contract. In this contract, there are six different criteria, where one naturally is price. Building time, environmental issues and mass balance is are some of these criteria. The focus on quality solutions and a clear vision and complete plan for the project is also valued in the process.

5 ANALYSIS

5.1 BUILDING TIME

As shown in the theory chapter, building time for all three PPP were significantly shorter than what the estimate for a standard contract form would be. This is one of the main advantages for the Norwegian PPP projects. When the concept of PPP has been mention in political debate, this is an element that there is put too little focus on. There are advantages with the significantly shorter building time. Although the project has not made any calculations on the socio economical gain in these cases, it is in the project group's opinion safe to assume that there are several societal beneficiary effects that comes from this. The users gain access to a better road, earlier, thereby saving time and lovers their exposure to the more accident-prone road they were using.

5.1.1 Interview findings

The construction company mentions some reasons for the shorter building time, and the free or self-financing of the building, the construction companies own planning freedom and the size of the project with several points of attack. Being able to plan the project after what elements that will take the most time is one of the elements that were used in the PPP project. Whilst the NPRA's way of organising the project, since they plan according to the yearly appropriation. The possibility for parallel building and planning is one of the elements the PPP companies highlight. The idea is that the building of certain elements of the project starts before all the planning surrounding the project is finished. This is a possibility the construction companies with regular projects cannot use, since the NPRA needs to approve all project planning, drawings and solutions for the project before any construction can start. The parcels are also usually shorter and the big road element, for example a long bridge, may be an own contract, with no other collaboration with rest of the project.

The construction company's execution freedom is an important factor that is mentioned in the interviews, argued to be an important factor for the reduced construction time. Operating at several areas in the project simultaneously results in better use of resources in the way of continued use of the work force and machinery. Solutions previously used by the construction company can be used, in order to ensure reduced time use and high implementation quality. If the project have several bridges or tunnels, solutions can be standardised for all constructions. This reduces costs and the time use, and possibly reduces the risk for large variations in the product quality.

The interviewees from the PPP companies believes the rapid implementation is a result of the design and execution parts of the project being organised by one party. Thus, the design and construction phase occur simultaneously with large overlaps. Results from the PPP projects shows that this is something the contractors use largely. Only some planning needs to be completed before the start of construction, whilst the rest of the detailed design can be performed simultaneously as parts of the construction work is done. This is not something the contractors from normal projects are able to do, where all the plans needs to be approved by the NPRA before execution can begin.

One PPP company representative highlighted the size of the project as the most important factor for shortening the construction time. The representative gave an illustrative example when mentioning the last part of E18 in Vestfold County, which is run as a traditional project. The total length of highway is about the same length as the PPP project E18 Kristiansand- Grimstad. The TP project was split into three project enterprises, whilst the PPP road is organised as one. At the PPP project, it is big enough for the contractors and all the involved parties so that they can fully use the resources at their disposal. As figure 34 in section 6.3.1 shows, it takes some time before the efficiency of an operation reaches its optimum. Although this figure represents one process or element, the idea is the same, and the idea of

what the representative said. This representative also mentions one element that is a result of the private investment banks. These banks/institutions had some demands in order to grant loans. One of which were they appointed a technical advisor, responsible of following up the governance of the project. The project was to be organised with milestones in progression, and the payments from the banks was linked up to the fulfilling of these milestones.

5.2 BUILDING COSTS ANALYSIS

Collecting useful construction costs for both the PPP road and a comparison stretch has proved hard. The project has simply failed in collecting reliable cost data. The main challenge is having reliable and comparable costs from both of the contract types. Although such data has been proposed, and there has been looked after data from different project from the central region, it has proved very hard. The main reason for this is missing data in the databases of the NPRA, as well as challenges regarding access to the database. Earlier, NTNU had access to the database through an account at the university, but this user is no longer available. However, that was not decisive, because the project group established contact with a responsible person for the Cost Database in the NPRA. The contact looked for relevant projects, but could not find any projects comparable to the roads analysed in this project. There are, as of today, no new projects in the central region with a combination of all road elements with an YDT, which is comparable with the main road.

The only available data came from a project further south of Bårdshaug. Although the road is part of the E39, it is not comparable to the Klett-Bårdshaug sector. There are relatively big challenges hindering the possibility of having a useful comparison of these roads. First, the road is defined as a S2 road according to the upgraded road standards. The road width is 8,5 meters, 1,5 meter narrower than Klett-Bårdshaug. In addition, the YDT is not comparable to the Klett-Bårdshaug sector. There are also other geographical challenges. The sector consists of two relatively short bridges and no tunnels, rather far away from the conditions at Klett-Bårdshaug. Thus, doing a comprehensive presentation and analysis of those data will not contribute to a better output of this project.

This is not a unique case only relevant for this project, according to more people within the NPRA. Sources has told that acquiring these numbers can prove very hard, and is causing extra work for employees who want to find historical figures in order to compare them with newer projects. However, the project is of the clear impression that the foundation for developing good knowledge through the cost database absolutely is there, and will prove helpful in the future as more projects are implemented in the database. This is of course subject to those responsible for the projects, in order to collaborate with those responsible for the database.

5.3 COST OF BID

The tendering process for PPP projects puts a big strain on firms. The combination of building, maintaining and operating the stretch of road for 25 years means that they have to invest more time and resources into developing the tender documents and cost estimates. The PPP form is also new to the construction companies in Norway, putting making it even more demanding. In comparison, the construction companies are more used to the system, have more experience with the tendering process and are more familiar with the costs in traditional projects. If more PPP projects are to be implemented, the project think the disadvantage with unfamiliarity will fade away, and approach the same level as with traditional projects.

5.3.1 Interview findings

It is argued that with the amount of risk the PPP companies take by biding at a PPP project, it is clear that the demand of resources is higher than for contract types where the risk is lower.

The bid process for the PPP projects is an element that one of the interviewees is that the bid process was too expensive. He argued that the need for so many rounds was ineffective in his mind. In a case where similar PPP projects are announced, the interviewee would like this process to not involve so many rounds, and would have the selection done earlier in the process.

Another element that is mentioned by an interviewee is that since the process is so big and financially demanding, it is crucial that more than one PPP project is put forward in the same time frame. It is easier for the firms to take a chance on using resources at a bid if there is a market for these types of projects. He admits that if there would have only been one PPP project put forward instead of the three trial projects, he doubts that his firm would have taken a chance on competing for the contract. He also mentions that since this is the first time they entered a bid for a PPP project, they had to "learn" this type of contract, which is not the case for an eventual new round with PPP projects, in turn lowering the cost to some extent.

One PPP company representative says that the bidding process combined with the financial model that is used in these projects are the two drawbacks with PPP projects. The bidding process is comprehensive, and involves many parties. The use of advisors and consultants throughout the process is a big expense, and the number of contracts needed with different parties is vast. These contracts are also a strength he mentions, since there is little room for misunderstandings and conflicts when these contracts are in place.

It is mentioned that a foreign contractor hade several solutions they had good experiences with in their country that they wanted to implement which the NPRA had no knowledge about. The process of getting these solutions approved by the NPRA turned out to be a "bureaucratic nightmare" resulting in the contractor giving up in trying to implement unknown solutions with NPRA eyes, and sticking to the road manuals.

5.4 DIFFERENCES IN GOVERNANCE AND PAYMENT SCHEMES

The more restrictive governance of traditional contracts is one of the big differences from PPP. The same can be said about the traditional way of financing roads, where many projects are finances over the national budget over a period of several years, making it harder for the contractors to build at the most cost effective way, making the construction time longer and can be more expensive. As Fridstrøm points out in his article, the payment model where a large portion is transferred back to the PPP company during the first few years is a better way of organising the payments than if they were evenly spread out over the whole period. In that way, the PPP company can pay back a large portion of its debts, reducing the amount of money diapering due to interest rates. This payment scheme is the one used for E39 Klett – Bårdshaug.

The opportunities the NPRA have in the payment scheme to deduct parts of the payments in cases of reduced quality, reduced operation time or road safety is a good incentive to keep the standard of quality that the public may enjoy, as is the high safety focus.

5.4.1 Interview findings

From the interviews, it is clear that the one of the major factors for the shorter building time and the measurements implemented to gain a higher quality and lower maintenance costs are the differences in governance and payment scheme. That the payments only start when the road is operational gives the companies the incentive to finish the building faster. The possibility to control much more of the planning and have control of the project timeline, where and how much resources are needed at each area of the road highlights the difference in governance scheme.

5.5 BUDGET OVERRUN

One of the arguments that have been used in the debates around PPP road projects in Norway, is that it is more expensive than conventional road projects (Bakke, 2011). These arguments are based on experiences from PPP project in other countries, which have a different financing model then is the case for the Norwegian ones. When the finances are not dependent on traffic amount, but a standard payment where the toll fees are re distributed back to the PPP company along with normal payments is the Norwegian model. This model does not have the same problems, since a lower traffic amount does not negatively influence the payments, but a large increase does influence positively. With a higher traffic amount, the toll income increases, in turn decreasing the need for public funds. Looking at traditional projects in Norway, as the project see in figure 34 that they normally end up with an average overrun that the NPRA and government has to cover of 4 %. Those types of overruns is something the company itself has to cover in a PPP project, like the large overrun in the E18 PPP project.

Figure 34 Average cost development through project development (Torp et al., 2012)

The fact that the price of building a road the last ten to twelve years has increased much more than the consumer price index as shown in figure 35 is something that can be an argument for PPP. Since the contract price for the whole project and the 25 years of maintenance is set at the signing, the problem of unforeseen increasing prices is not something the NPRA and the government has to compensate for. In TP projects, where the building is financed over several years, this could be an issue, and especially when it comes to the cost of maintenance after some years of operation, when a new maintenance contract is needed. Then the possible higher prices can have an effect that is not the case for the PPP projects, where the risk of price increase is put on the PPP company.

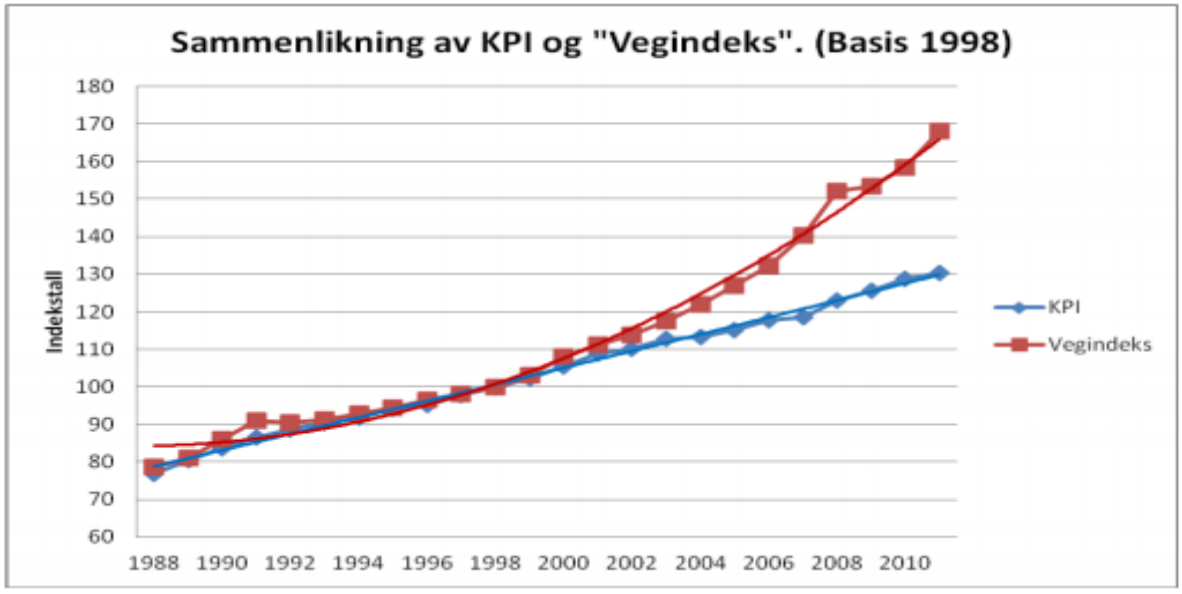


Figure 35 The development of the road index compared to the consumer price index (Torp et al., 2012)

5.5.1 Front-end Management

Front-end management is thought of as something that in general can be a good influence on reducing the total costs of a project. By using more resources in the early planning phase of a project, the need for implementing amendments in the later phases of the project when it is much more expensive can be lower. The cost of amendments are at its lowest and the uncertainty is at its highest, in the front-end phase. The earlier the construction company and architect are involved in the planning of the projects, the more likely it is that they can be a positive influence on pushing for addition amendments earlier in the planning phase, at a lower cost than if they are not involved in the planning.

5.6 IMPROVEMENTS ON QUALITY AND STANDARDISING

In the questionnaire, question four was regarding the willingness to do changes in order to reduce maintenance costs and increase the overall quality. The respondents all score this question above six, and the representatives from the NPRA and TP contracts gave a higher value, compared to construction companies and PPP projects. All were quite high, indicating that the focus on quality is not where they would like it to be when building roads today. One of the PPP representatives gave a low score for this means. It is believed the cause of this is that they in these projects have made changes regarding this matter. These results were taken into account when developing the questions for the interviews, in order to see whether the interpretation of the findings are shared with the interviewees.

5.6.1 Interview findings

From the PPP companies it is told there were made considerable savings due to the standardising of elements. Since the projects were large and contained several bridges, which is an element that contains many components that are easily standardised. Portals for tunnels are one example of an element that can be standardised. The fact that the NPRA does not make more use of the advantages of standardising than they are doing today is mentioned. A simple thing that can illustrate this is pedestrian bridges over roads. Now there probably are around a hundred different bridges to choose from. One would think that there should only be two or three. The gain of standardising is illustrated in figure 36.

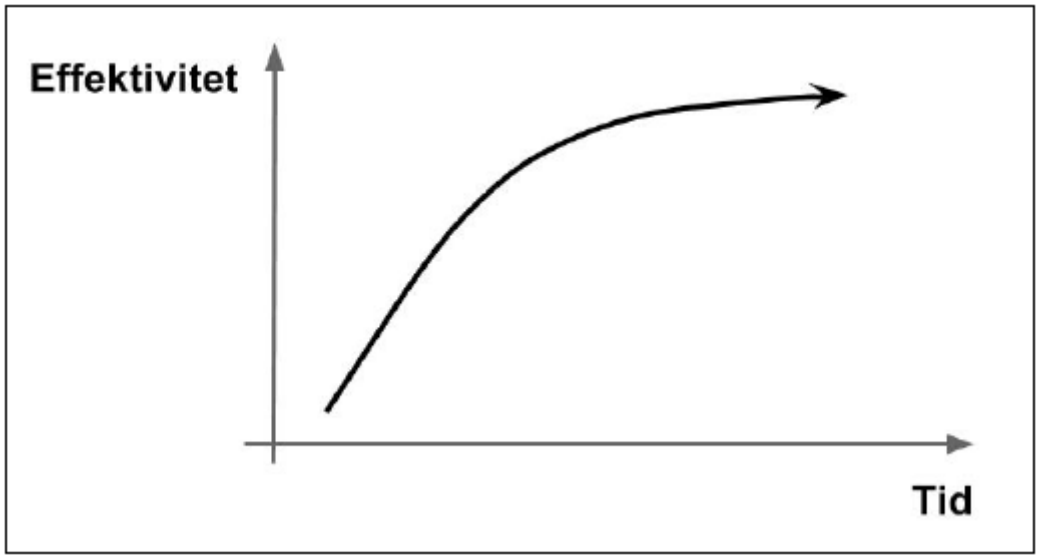


Figure 36 Effect of standardising over time. Efficiency over time

5.6.1.1 Quality

During the planning phase of one of the projects, the PPP company involved the maintenance and operation personnel in the design process. This was done in order to take advantage of these people's experience and knowledge when it comes to measures that could be of use in the reduction of maintenance costs. In both the E39 PPP projects choices were made with the reduction of the operation and maintenance costs. Under one interview, the interviewee specified that there was a focus on LCC under the planning and designing of the road. The focus on LCC is also one of the reasons the operation and maintenance personnel was involved in this process. The motivation of course largely being the potential for saving money on this budget cost. Some of the quality improvements and changes done compared to a traditional road construction project is presented below.

5.7 INNOVATION POSSIBILITIES THROUGH PPP

One of the problems the project was hoping to answer, was whether the companies owning and operating the PPP's did any changes compared to the conventional road contracts in order to reduce the total LCC. E39 Klett-Bårdshaug was the original road in the problem statement, but as described earlier, the project has expanded this to include all the three PPP projects. The project have found that the different companies has made major changes in order to reduce the LCC. As the project can read from the findings in the interviews, the E39 Klett-Bårdshaug made some major changes in the construction phase, because they believe that these changes will affect the LCC cost in the positive way over the lifespan of the road. To clarify, this lifespan is 25 years in the private operators mind – the public is still responsible to operate and maintain the road afterwards.

5.7.1 Thickening foundation layer

One of the changes from Klett-Bårdshaug was thickening the foundation with 30 cm in order to avoid frost heaving. Distance of the road in the day is 15,2 kilometres, and the width of the road is approximately 10 meters including shoulders (plus sectors with three lanes). If following the road standards of the time, the total amount of extra foundation counts to around 50 000 cubic meters. This is an approximate number just to get an impression of the extra volume of foundation layer. The project have not obtained the extra cost for foundation, but the cost is probably a significant extra

expense. To justify the extra expense, there must be analysis made from the PPP company that concludes with high savings in connection with this extra work and expense.

5.7.2 Extension of the Storsandtunnelen

Another improvement of the additional project plan at the E39 Klett-Bårdshaug project is the extension of the Storsand tunnel with 160 meters (Hanssen, 2008). From earlier, it is agreed that tunnels are very expensive, both to construct and especially maintain, compared to a normal road (Gustavsen, 2008, Pettersson, 2012). Thus, it is surprisingly to us that they on a voluntary basis, with no extra funding from the public, chose to extend the tunnel. The project have thus tried to illustrate the extra cost the PPP company has chosen to take because of this change.

Because of lack of data, it is hard to obtain a clear view of what is the extra construction cost of a tunnel. However, there are no sign of a correlation between price and length, when thinking of cost per unit. Regarding maintenance, it is possible to measure differences. It is interesting to analyse what extra maintenance cost the PPP company has taken in order to do this change. For calculating the extra maintenance cost for this tunnel, the measured traffic and forecasted traffic for the tunnel over 25 years is applied, and calculated maintenance cost for the sector for both tunnel and road in the day maintenance. The excel sheet calculates the extra maintenance cost for a tunnel compared to a road in the day - (maintenance tunnel - maintenance road.) The function is applied to the measured and forecasted YDT for the Storsand tunnel over the operation period, to identify how much extra cost that probably has been added to the maintenance budget. With a discount rate at 4,5 %, this adds a total discounted maintenance cost of over 1,6 million over the 25-year period (see figure). The values are in the krone value of 2013, discounted both backwards to 2005 and forward until 2030.

Table 18, Extra maintenance cost for Storsandtunnelen

Traffic prognosis Storsandtunnelen				
	rate	4,50 %		
	kilometers extra tunnel	0,16		
	Year:	Cost in the actual year (2013 value):	Measured traffic	% increase
1	2005	kr 42 776,51	6313	100 %
2	2006	kr 82 875,87	6428	102 %
3	2007	kr 83 161,40	6821	106 %
4	2008	kr 81 424,47	7029	103 %
5	2009	kr 78 800,53	7151	102 %
6	2010	kr 75 407,21	7176	100 %
7	2011	kr 75 392,11	7507	105 %
8	2012	kr 72 145,56	7599	101 %
9	2013	kr 69 778,75	7678	101 %
10	2014	kr 68 190,06	7869	102 %
11	2015	kr 66 608,80	8066	102 %
12	2016	kr 65 037,28	8267	102 %
13	2017	kr 63 477,59	8473	102 %
14	2018	kr 61 931,63	8684	102 %
15	2019	kr 60 969,29	8901	102 %
16	2020	kr 59 431,27	9123	102 %
17	2021	kr 57 912,64	9350	102 %
18	2022	kr 56 414,61	9583	102 %
19	2023	kr 55 414,66	9822	102 %
20	2024	kr 53 940,27	10067	102 %
21	2025	kr 52 926,42	10318	102 %
22	2026	kr 51 482,34	10575	102 %
23	2027	kr 50 464,03	10839	102 %
24	2028	kr 49 437,95	11109	102 %
25	2029	kr 48 040,79	11386	102 %
26	2030	kr 23 511,20	11670	102 %
		kr 1 606 953,26		
NB!	0,5 years operation in the first and last year	Measured traffic from NPRA		
		Forecasted traffic by the project		

This is clearly done in order to strengthen the road quality and minimize the risks for severe extra maintenance costs, for example caused by landslide in the area where the extra tunnel is made. There is perceived that the extra maintenance cost of 1,6 million as well as undisclosed construction cost is worth to pay as an extra "insurance" premium to reduce other risks that could arise from the sector that now is in tunnel. The clean-up from a big landslide, for example, is perceived to be much higher, taking into account that the company is paid for keeping the road open, in addition to the direct costs from the clean-up work. Especially if it is a recurring event, and then there is the possibility for lost lives in the event of a landslide taking a care with it.

5.7.3 Energy saving innovation

During collection of data and interviews, there is identified that electricity costs adds up to a very high portion of the total operation costs. To exemplify this, the project present a table from the report "Moderne Vegtunneler." This is presented in the Table 19 below, which cover all tunnels on the highways in Norway.

Table 19, Overview of costs for tunnel operation (Highways) (Vegvesen, 2012)

Riksvegtunneler Sortert etter største kostnadspost	Totale kostnader		Kostnader pr løpskm	
	Drift/vedlikehold kr/år	Rehabilitering kr/år	Drift/vedlikehold kr/år	Rehabilitering kr/år
Strøm	99 079 244	0	159 664	0
Tunnelkonstruksjon	83 824 528	333 391 811	135 081	537 254
Reinhold	63 896 413	0	102 968	0
Strømforsyning/fellesanlegg	45 136 895	43 210 672	72 737	69 633
Dekkevedlikehold	42 562 299	0	68 588	0
Sikkerhetsutrustning	32 926 947	65 881 517	53 061	106 167
Belysning inkl kabelbru	26 862 233	111 439 804	43 288	179 583
Ventilasjon	14 689 192	40 202 073	23 671	64 785
Reparasjon av elektroinstallasjoner	9 134 328	0	14 720	0
Oppmerking og optisk ledning	8 005 086	0	12 900	0
Trafikkberedskap	6 333 649	0	10 207	0
Pumpe	4 193 870	0	6 758	0
Luftrenseanlegg	3 050 667	0	4 916	0
Drenering	2 685 223	0	4 327	0
Rekkverk og støtpute	1 145 249	0	1 846	0
Kantstein	986 342	0	1 589	0
Kuldeport	525 652	0	847	0
Avfuktingsanlegg	0	0	0	0
Hendelsesdetektering	0	0	0	0
Sum	445 037 817	594 125 877	717 169	957 421

The table confirms what other literature states, and is applied in order to analyse how PPP has made an impact in such a case. The Klett-Bårdshaug road has an YDT of between 6000 and towards the end of the contract, probably exceeding 13000 cars per day. From the figure 37 below, the project can see that the electricity costs not seem to decrease, but rather increase in future tunnel project with the same YDT as this road project.

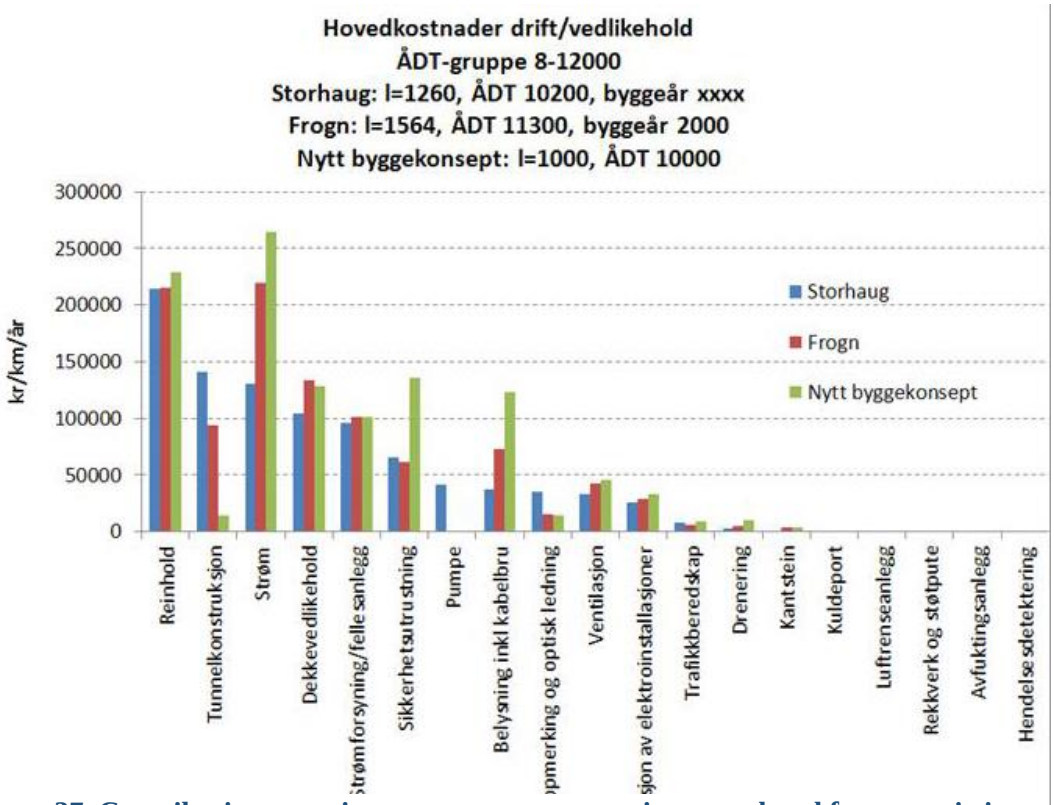


Figure 37, Contribution to maintenance costs per cost item, analysed for two existing tunnel and a new building concept. Green color indicates new building concept (Vegvesen, 2012).

It is very interesting to see that more of the PPP companies have taken action in order to reduce these costs. In collaboration with others, Orkdalsvegen have implemented the first full LED lighted tunnel in a Norway (OneCo, 2013). The aim is to install LED lightning in all tunnels if it proves successful, according to the PPP company. They calculate to save around 200 000 kwh per year, as well as increasing the life of the light bulbs from about four to between fifteen and twenty years (Dyreland, 2013). The NPRA is very interested in the new technology, and state that they believe that every new tunnel built in a couple of year's time will include LED lightning (Wanvik, 2013). Regarding the LED lightning, there are several other benefits, such as the possibility to dim the light when no cars are in the tunnel and adjusting the lightning in the ends of the tunnel to match the outdoor light.

The PPP project down south, at E39 Lyngdal-Flekkefjord, has also taken action in order to reduce electricity costs. In order to save costs, they used lighter mineral aggregate in order to enable to use the natural light to reduce the need for artificial road lightening at dusk and dawn. The contract states that the light is set to be at a certain lux value, and the lighter mineral aggregate has contributed to saving costs for electricity. This is clearly done in order to optimize the costs for the life cycle of the road project. Thus, this is contributing to innovation and more environmental and money saving in operation of the roads.

5.7.4 Savings in asphalt technology

From both of the diagrams above, one can also see that pavement maintenance is supposed to be a significant post in general operation and maintenance budgets. In order to try to reduce the demand for frequent maintenance, the PPP Klett-Bårdshaug made the layer of asphalt just below the abrasion layer stronger in order to save costs on that post. From the interview with the representative from this project there has been identified that they have now postponed planned pavement maintenance. The reason is that it is not necessary to do it now, even though the traffic has increased more than forecasted. One of the other PPP projects also reported that strengthening the asphalt quality has saved the company costs on that post. However, the change was a little bit different. There the abrasion layer was improved with a better chemical mixture in order to stand the tooth of time and cars a little longer. According to the interviewee, the improvement has proved cost effective. This show that the innovative experiments has proved valuable, and at least should be adapted by the NPRA for test sectors at other highways with high traffic volume.

5.7.5 Other improvements

In areas with clay and with high risk of flooding, foundation rocks were placed along with other measures to reduce the need for maintenance. In tunnels there are several rooms containing sensitive technology and electronic components. The dust that gathers in these tunnels is not something that should get near this equipment. These rooms was thus designed with overpressure, making it much harder for the dust to get in.

5.8 CHANGE ORDERS

When talking to both representatives from the NPRA and from one PPP company one aspect mentioned was change orders. In standard operation and maintenance contracts where the duration of the contract is much shorter than for the PPP contracts. Changes in the operation standard and other similar factors can then be integrated into the new contract, whilst in the PPP contract there is no room for new demands. Therefore, if the NPRA finds that some of the new standards are so important, they will need to go into negotiations with the PPP company so that there can be a change order where the PPP company is compensated for the extra expenditures. Measures that are more likely than others are with respect to road safety and lowering the number of traffic deaths.

5.8.1 Interview findings

Change orders is a natural part of the contracts since they have a lifespan of 25 years. According to all the interviewees, change orders have already happened. They have not experienced any problems agreeing with the NPRA about the parameters and compensation for these changes. One of the interviewees says that it is up to the NPRA to deem which changes are necessary and which are not. Some elements might have already been implemented as a measurement for extending the LCC, when these measurements are implemented in the operation standard. This can be the case since the PPP companies researched what new technologies and solutions might be beneficial for them in the LCC perspective and in terms of saving total costs. The type of harder and more durable asphalt, and the measures for keeping dust out of sensitive rooms in tunnels might be an example of this, even though the project team is uncertain if these measurements are a part of the road standards yet.

5.9 TECHNOLOGICAL INNOVATION AND CHALLENGES REGARDING CHANGE ORDERS.

The project owner must have lots of emphasis on thinking of future possible happenings, and considering those in the contract formulation. By default, the standards of the time of contract signing is valid through the whole contract period, even though the standards are upgraded (Horvli, 2013). For example, is the Klett-Bårdshaug sector monitored and supposed to be maintained according to the standards of 2003. This means that the requirement for rut depth, cutting of grass, ploughing regulations etc. follows the 2003 standard through the whole operation period unless there is an agreement of upgrading the contract. The long contract period is in this case a major disadvantage in cases where unforeseen innovation applies. There is hard to identify all innovation that applies to the future, and there is normal that challenges arise in this connection. In general, one can use a matrix to define how to cope with changes, presented in the table below.

Table 20, Overview of technological innovation scenarios and how to deal with them

Foreseen innovation, NPRA responsible	Unforeseen innovation, a need for negotiations
Foreseen innovation Choose to do nothing; Steady-state	Foreseen innovation, PPP responsible

The challenges here arises when the innovation is identified as an upper right corner innovation. An example of the challenges regarding this is the administrative monitoring of all maintenance and operation contracts in Norway. Through the program “ELRAPP” who was introduced in late 2007, 4 years after the agreement of the PPP Klett-Bårdshaug. ELRAPP is a way of having a uniform monitoring of maintenance contracts. By not having this implemented in the PPP contract, the NPRA is forced to have an extraordinary way of monitoring this over the rest of the lifespan of the contract, as well as experiencing challenges towards the National Audit Office, because of the lack of proof of monitoring (Øien, 2013). Other challenges identified as technological innovation, is introduction of DAB radio and emergency communication in tunnels and new standards for road markings (Fuglset, 2014).

From the project's point of view, the need for upgrading these standards are subject to the cost versus risk of not having the upgrade. However, there is also clear that the contract formulation encourage the PPP company to implement such innovation, through the bonus scheme for traffic safety and availability. In such way, the public has kept the premium for safety and having good quality as a strong incentive to make the PPP operator having high emphasis on safety measures. This scheme is clearly a good way of encouraging the private operator to conduct changes that contributes to saving lives and keeping the road open.

5.10 TRAFFIC PROGNOSIS AND MAINTENANCE COST CALCULATIONS

The data obtained and used is presented in the empirical data chapter. In the following paragraphs, different findings about maintenance and operation of the PPP Orkdalsvegen will be presented and analysed.

5.10.1 Additional way of measuring traffic and traffic increase premium

During this project, there is identified that traffic prognosis is used to calculate whether an extra premium should be granted to the operator of the road. The contract agreement states that the average of the three latest measuring points is used as forecast comparison. In addition, the junctions along the road combined with the traffic data measured from the NPRA is used to find out how many cars that are using the different parts of the road. The total road sector is 26,9 kilometres. In total, there are four measuring points when including the one at Øysand. Each measuring point is representing a main junction. Because a vehicle cannot exit the road other places than these junctions these data are very reliable, even though there are two extra junctions. One of the junctions are located right after the beginning of the road, in front of the first measuring point. The other junction is located at Thamshavn, after all the tunnels, and is in reality a second option exit for Orkanger, in addition to the roundabout at Bårdshaug. The traffic lost from these two junctions are believed to be negligible in the maintenance cost perspective in this project. In addition, it is worth to mention that these two junctions represent the start and finish of the 21,9 km sector of new road for the PPP project. Thus, it is possible to measure the volume of cars using the different percentages of the road.

Table 21 Model of additional way of measuring traffic

(utvalg)	Measuring point	Øysand	Brekktunnelen	Mansfjellt u-nnelen	Storsand	Total		
	Percent of the total road stretch (from Klett, 26,8 km)	17 %	11 %	24 %	48 %	100 %		
	of sector (Meters from Klett	4511	7563	13878	26839	26839		
	Measuring point (mtrs from Klett roundabout)	2898	5188	10388	20268	Percentile calculation	percentile taken into account	
	Traffic prognosis E39, from contract.						prognosis + 20 %	Extra payment?
2005	6904	9705	8251	7894	6313	7475	8285	no
2010	7563	10885	9275	8774	7176	8414	9076	no
2015	8480	12148	10519	9810	8066	9441	10176	no
2020	9447	13377	11887	10839	9123	10556	11336	no
2025	10280	14731	13433	11976	10318	11804	12336	no
2030	11173	16221	15179	13233	11670	13202	13408	no
							extra:	0
	Prognosis from PPP contract							
	Measured traffic from NPRA							
	Forecasted traffic by us							

As presented in the tables below, every part of the road is given a percentile of the total, and add all these numbers in order to get the correct percentile number of traffic. This is done this to show a different way of measuring, where the factual use of the road is even better illustrated. A challenge related to measuring this way arise if parts of the road sector differences much between each other, for example a sector with a long tunnel continued with a sector of straightforward road in the day up in a relatively flat terrain. Then there are big difference between the sectors, and the value for each of the road parts should be given a maintenance factor. However, on this sector, the tunnels along the road are relatively evenly distributed, with the longest part of tunnels being in the longest sector of the road (Børsa-Bårdshaug). However, there is no tunnels in the first sector, but a relatively long bridge. The bridges also are relatively evenly distributed. In this example, one can also discuss whether one should get extra payment for increased traffic on the area where the road only is upgraded, not constructed from the bottom. The project group feel this it is fair to include, because the PPP company has the maintenance responsibility there as well. In the table below, some of the values for the 25-year period are shown.

By having this alternative way of measuring, it is also present a different way to calculate maintenance cost. As presented in the empirical data chapter, only the three last measuring points are used as basis

for calculating the prognosis. By doing that, the NPRA has agreed upon a good deal for themselves, because the part of the road with highest traffic, Klett-Øysand, is not included in the calculations. There may be several reasons for that, probably mainly because of that the sector is in general upgraded existing road. In addition, the road sector only include road in the day and a bridge, and was maybe seen as an easy sector to operate. However, there is chosen to illustrate how this works would have impact in practice. By using the model made for analysing the maintenance cost, there is measured different costs from the different parts of the road in order to show if the correlation between the costs are better with the alternative way of measuring. As visible can see from the table 22 below, the total sector length is 17 % of the road, and uses 13 % of the maintenance budget.

It is important to remember that this way of measuring traffic should take into account how the traffic volume is distributed through the total road parcel.

Table 22, Maintenance costs compared to road sectors

Contribution to total:	Total maintenance cost over PPP lifespan (25 yrs.), 2013 value	Per cent of total maintenance cost	Contribution in traffic forecast calculation	stretch per cent of total road length
Klett-Øysand	kr 46 417 311	13 %	0 %	17 %
Øysand-Buvik junction	kr 52 149 413	15 %	33 %	11 %
Buvik junction-Børsa junction	kr 94 502 458	27 %	33 %	24 %
Børsa junction- Bårdshaug	kr 156 379 828	45 %	33 %	48 %
total	kr 349 449 010	100 %	100 %	100 %

As the table shows, there is a high correlation between sector length and the contribution to maintenance costs from the different sectors. The model describing this correlation gives an interesting view. Although there are no tunnels on the sector Klett-Øysand, there are a bridge, which contribute to increasing the maintenance costs. The correlation between road length and maintenance cost are very comparable and do not have a severe deviation from the conceptual costs found by the model. The calculation model shows that the percentage of the road is not used as basis for maintenance costs. As these data are based on the report by ViaNova, it does not represent this road sector specifically, but any road sector that somehow can compare itself to this. For later projects, the project can see that the correlation is high enough in this project to recommend the method for later projects.

One important point is worth mentioning in this connection, and that is the correlation of traffic on the traffic and the road stretch. There should be a correlation between these, which is easy to identify using historical figures, to see whether the way of measuring is feasible.

5.11 OTHER FACTORS

5.11.1 Duration of contracts

In question five of the questionnaire, where the question was how the length of today's contracts were perceived, the majority of the respondents answered between good and that they should be longer. The TP representatives were the ones that answered that the contracts should last longer, whilst the PPP representatives mostly answered that they were good today, though one of the NPRA representative responsible for a PPP project wanted it to be shorter. When talking with people at the NPRA and Ivar

Horvli especially, they indicated that this was something the NPRA was aware of, and that these people at least were thinking of the possibility to make a bit longer lasting contracts.

5.11.2 Supervision

In the questionnaire there were two questions surrounding the topic of supervision. With the varying results, this topic was necessary to include in the interviews. From the interviews, it is said that when it comes to the building phase of the PPP projects, there is a clear difference from traditional projects. Where the NPRA has around 40 representatives supervising the building process in a traditional contract, there were four representatives in the PPP projects.

In the maintenance phase, the amount of supervision was perceived as a bit more intensive than for traditional projects. The arguments from the PPP representatives on this was that it is clear that the NPRA is eager to keep track of the quality of the road, installations and other factors that can impact the scoring system. Firstly, to check that what the PPP company is reporting is the truth, but also to keep track of what they eventually will take control over, so they have an overview when the time comes that they will be responsible for the maintenance.

One of the interviewees says that with the focus they (the PPP company) have on their own sub-contractors, is clear that possible problems often are brought to their attention before the NPRA are aware of it. Their focus on quality of service, and the fact that this is in their own interest makes for a trusting relationship with the NPRA, meaning that the NPRA can use more of their time on the conventional contracts under their supervision.

5.11.3 The financial model

One of the representatives from a PPP company mentions the financial model as one of the not so god aspects of the PPP project. With this, he meant the big expense of paying the interest rate on the loans. The felt that with the new government and what they have been saying about the public financing is a god step. With a smaller percentage of loans, and a bigger percentage of public financing, it would be possible to have the same project at a lower cost.

Other representatives from PPP companies have to some extent mentioned the interest rates as a problem as well, but there is an aspect to take into account here, and that is that two of the project have a flat payment structure, whilst the third has a three-step plan. The representative that mentioned the financing as a drawback came from one of the projects with a flat payment plan.

5.12 COMPARISON OF MONITORING OF OPERATION AND MAINTENANCE

In general, it seems like the incentives regarding maintenance and operation in the PPP is working very well. The deduction points is a clear incentive to not default the contract, and the demand for documentation from the PPP company enables the NPRA to have a close monitoring of the situation. As well is high quality in general said to be an advantage, because of the ownership the PPP company has to the road. Not keeping the quality up to date only comes back to themselves, and slowly tearing the quality of the road, which is forcing the owner to take other (probably more expensive) actions in order to keep the road according to standards. One of the interviewees from the PPP draws clear lines between this collaboration in connection with the maintenance monitoring on the PPP roads. The main reason, who was used for this, was that the PPP company also has to monitor their subcontractor responsible for operation. In normal contracts, the penalties comes if the NPRA reveal lack of functional requirements, for example too much snow, too icy and so on during winter. The monitoring is the only incentive the companies has, because the operator of the road itself has no ownership for

the sector. In such cases, which also is confirmed from the questionnaire, the quality of the road would have been better with higher measuring from the road owner.

5.13 TRANSFER OF RESPONSIBILITY FROM THE PUBLIC TO THE PRIVATE

On questions regarding the need for monitoring in the PPPs, all the interviewees says that the need for monitoring is decreased in both the construction and operation phase. When also including thoughts about the slowly aging engineers in the public and the lack of young blood to take over when they are becoming seniors, a solution to this arises through PPP. Regarding need for labour, the PPP contracts can help the public in the lack of qualified labour. Following the findings in the interviews, the public commitment to the private projects are lower, because of the private responsibility for the roads. It is very early to conclude with anything on this point, but if the lack of public engineers become real, using more PPPs may be a way of solving this challenge. A challenge related to this will be the possibilities that small construction companies face with lower volume of tendering competitions from the public. Many regard the public procurement process as cumbersome, but fair. With larger projects, the companies bidding for the project will also be larger, probably the same in many cases, which enables them to run hard negotiations towards its own subcontractors, and use other ways of acquiring subcontractors than the public system does.

It is not believed that smaller construction companies will be removed from the market, it is rather so that the market for the smaller construction companies will move more towards subcontractor assignments in larger PPPs if the scenario become reality.

5.14 ROAD DEVELOPMENT CONTRACT, AN ATTEMPT AT IMPLEMENTING ELEMENTS OF PPP INTO TP

As a result of the three trial PPP projects, the NPRA decided to attempt at implementing what they saw as the positive elements of the PPP. Drastically reduced building time and the increased focus on a holistic plan for the whole project, including maintenance costs and LCC, are some of the central elements.

The payment model is not transferred to the road development contract, and the contractors does not have the same freedom when it comes to starting the construction on certain elements before all the project planes are approved. However, the payment plan is designed with inspiration from the PPP projects. The contractor will be paid portions after the completion of certain elements or milestones, and at the completion of the building period, the building part of the cost is transferred, with a bonus or deductions for improved or delayed building time, and other criteria the NPRA can deduct for stipulated in the contract. The availability and traffic flow during the construction period being one of these deduction criteria. For the PPP projects, starting the construction whilst some of the planning was still going on was one of the elements they used much. Starting the construction of tunnels and bridges, which takes the most time could start before the planning surrounding the other roads was finished.
As one of the PPP company representatives' mention, the fact that the projects are much bigger than what is ordinary is in his mind one of the biggest factors leading to shorter building time. This is one of the elements that the road development contract does partly adapt, which can give the desired effect of reduced construction time.

5.14.1 Interview findings

Incentives such as the construction companies own gain in having expensive machinery at the site for a short time ass possible is one of the issues that is mentioned that can lead to shorter building time.

In this total enterprise contract the possibility of starting construction whilst some planning is still going on is not an option.

Shorter construction time is listed as one of the issues that can result in a type of bonus. This is organised in the manner of the NPRA estimating a mean construction time. As described in the interview findings, interviewee 4 gave an example of if the construction mean time is set to 3,5 years. The company will get a bonus if it is from 3 till 3,5years, but no bonus for completion earlier than that. He did mention an interesting aspect regarding this. He emphasised that there is a breaking point for the reduction in construction time, and that there should be a realistic estimate, so that the reduction of construction time does not lead to a reduced focus on the health and safety of the workers, the breaking of the work environment act and the quality of the solutions.

One of the elements mentioned in the interview was the selection criteria in the contract. Many of the TP contracts only or mainly have a focus on cost. This is not the case for the road development contract. In this contract, there are six different criteria, where one naturally is price. Building time, environmental issues and mass balance is some of these criteria. The focus on quality solutions and a clear vision and complete plan for the project is also valued in the process.

One extreme issue that can occur is an issue with the payments. There is no finance guarantee from the government. This can in an extreme case, where the NPRA does not receive enough funds from the government, lead to the defaulting of their payment commitments towards the contractor. In other projects, this is solved by using toll money, but in the trial project, there are not that many toll areas. The interviewee stresses that this is a very unlikely scenario, but none the less a scenario that can occur.

The competition builds on regulation plans, but the roads are not specified in details, there is more of a demanded function, something that the PPP was the inspiration to. When it comes to the use of standardisation, the contractors here have the same incentives as the PPP contractors, in the sense of reduced construction costs. With the function description, the possibility of standardisation is quite real.

6 CONCLUSION

When looking at what elements in the PPP project E39 Klett - Bårdshaug that effect the LCC, several factors that can be hard to transfer from PPP to traditional contract forms, including total enterprises such as the road development contract is identifiable. The payment model and scheme is something you only get with a PPP project, and though the road development contract as taken inspiration for their payment model, it is not believed they can expect the same dimension of effect as for the PPP contracts. The findings of the project shows that it is reasonable to attribute many of the positive sides of PPP to the payment scheme, but also more of the negative sides. However, there is believed that the most negative side can to a large degree be solved with the suggestions later in this chapter. The measures the PPP company put into place in order to save money on maintenance costs, also leads to a lower LCC. The effect of it being a large project with respect to building time is something believed the road development contract can obtain to a certain degree, but this has no direct link with LCC. Although the road construction manuals are based on much experience regarding road ware, there are some elements that the PPP company has implemented which was not listed in the manuals. The strengthened asphalt layer has already given results, and there has been no problems with frost heaving. It is believed PPP could be even more effective with respects to LCC if the companies could more easily implement solutions the NPRA are not aware of, but that has been tested out in other countries. This is also something the NPRA should take into account for their traditional contracts.

As described in the problem statement, there are three main points we wanted to research in this thesis. The three points are divided into three sub chapters in the conclusion, with the same sequence as the points are presented. As a reminder, the three points are shown below.

(1) Create an overview over contract details in the three existing Norwegian PPP projects and compare it to the traditional contract formulation regarding both construction and later operation of the road. The aim is to find a way to describe the governance and payment scheme for PPP compared to traditional contracts.
(2) Consider factors that influences the LCC in the PPP contract E39 Klett-Bårdshaug, and evaluate findings with traditional construction and operation contracts.
(3) If possible, find a conceptual estimate for the LCC at E39 Klett-Bårdshaug, compared to LCC for similar road elements (road in the day, bridge, and tunnel) from traditional road construction contracts regarding both construction and operation.

6.1 DIFFERENCES IN THE GOVERNANCE AND PAYMENT SCHEME FOR PPP COMPARED TO TRADITIONAL CONTRACTS.

With the financing coming from private banks and investment banks, certain demands and criteria is set by them, if they are to agree to a loan. One of the central criteria is having their own technical advisor that will keep a watchful eye over the project. The payments are linked up to the fulfilling of milestones, and the advisor monitors this progress. This link between milestones and payments, together with other project governance criteria is one of the elements the project think helps make the PPP projects a success. Since the PPP company is a private company, it is in the project's minds clear that the focus on a profit is a greater motivation than the motivating factors traditional projects are governed by. The same goes for the new road development contract. The risk of losing money on deductions due to lack of quality or safety standards is not something the PPP companies can live with, and this risk is not something the contractors in traditional projects experience. When it comes to

the road development contract, it would give a good effect if some of these operational criteria were used on their maintenance part of the contract.

As the analysis shows, there are different ways of organising the payments of a PPP project. The model used in the PPP project E39 Klett – Bårdshaug is in this project's mind the best one, both with the possible earnings of the PPP company in mind, but also looking at it from the perspective of a taxpayer. If more PPP projects are to be started, with this payment model, the total price can be lower than if the payment model was a flat scheme as it is for the other PPP projects. By receiving the majority of the contract amount in the payments received the first years, the PPP company is able to pay back a big portion of their loans, and in turn lowering their extra costs of maintaining the loan. A smaller loan is easier to maintain than a big one. This way of organising the payments might also free up capital and make it easier for companies involved in one PPP project continue with a new one. For smaller projects, it is not necessarily, given that a PPP project is the best, but looking at infrastructure projects with highways, it is a fully viable alternative to traditional contracts and total enterprises.

In the PPP projects, the option of starting the construction of certain elements such as tunnels and bridges whilst some other parts of the planning was still going on was used to a large degree. This is something thought to be a good help in the respect of reducing construction time. In the traditional contracts including the total enterprise and road development contract, this is not an option. The NPRA does not allow the start of construction before all the plans for the whole project are approved by them. This issue can be a big contributor for the shorter construction time. However, it is important to take the aspects regarding too big of a focus on construction time, possibly leading to the reduced focus on health and safety among other things, mentioned by the road development contract representative.

The analysis of the elements in the existing PPP contracts and ideas from the interviews has given ideas about some changes to future PPP in Norway. Combining the payment plan used for E39 Klett – Bårdshaug with a bigger portion of public financing will reduce the cost of PPP, but keep the advantages it creates. If the loans are all paid back within the first few years of operation, the extra cost of paying interest rates will be much lower than today, but the project still gains the advantages that comes from the demands set by the investment banks. The project are of the opinion that demands work better that if the NPRA would try to do something similar. This way the projects take the advantages with private corporations and their need for structure and profit.

The scale of the project is an element that is also positive with the PPP projects. Because of this, the NPRAs road development contract has larger enterprises than what is normal for traditional construction contracts. Combined with longer lasting maintenance portions in the same contract, it will be interesting to see whether these projects get the same results as the PPP projects. Both with reduced construction time and increased focus on LCC and maintenance. If this project will be cheaper than the project estimate or if it follows the trend of budget overruns from other traditional projects. By not having the finance incentive, with both the delayed payment, and the demands for governance put forward by the banks, it will be hard to get the same results regarding the same amount of construction time reduction, but several of the other factors such as quality can be achieved.

6.2 FACTORS INFLUENCING LCC

In the problem statement formulation, the focus was aimed most at the factors influencing the Klett-Bårdshaug. However, during the period of the thesis, the group revealed that different optimizing factors was used in all the trial PPP projects. Thus, factors from all the projects is given emphasis

during the work. By the analysis of the projects, there has been revealed that the companies did several changes in order to optimize the LCC of the road. The main examples is found in asphalt technology, where all three projects chose to make a kind of modernisation in order to save costs. The most interesting point in this analysis, was that all three projects did changes in the asphalt, but with different mission and in different ways. Both electricity savings and slower tearing of the abrasion layer has been used as reason for upgrading the pavement.

Regarding lightning, Orkdalsvegen has now implemented LED lightning in some tunnels, and estimate to save 200 000 kWh during a year. If all road lighting could be changed to LED, the savings for the public will be huge. The NPRA is also aware of this lightning technology, and plan to implement this to all new road sites in a couple of years. One of the large challenges for the NPRA in general, is the lag of upgrading old road parcels, and it is believed to take many years before all lightning is upgraded. At least 20, as the lifetime of a light bulb may reach that age. As PPP projects has more focus on saving costs during operation, it is believed that LED lightning will be implemented faster at those projects.

Orkdalsvegen also built a the longest tunnel 160 meters longer in order to reduce risk of landslides, which is regarded as a rather major modernisation of the original road plan.

The conclusion to this point must be that there are, according to the PPP companies, costs to save by having a longer period than the initial cost. The results are not visible to the project now, even not for the operators of the road. Although all see positive, economic sides already. Anyways, there should not be made clear conclusions on this point before even more years in operation has passed. The reason is that one should see if other factors influence the changes with more years in operations. Least, the factual cost savings will not be able to identify before the end of the contract period.

Finding the right discount rate to use in order to find a best possible value for the total project was also important. In this project, 4,5 % was used because the discount rate had been used at other similar occasions, and was chosen and identified as the best suited rate.

6.3 CONCEPTUAL ESTIMATE

On this measure, finding conceptual estimates for the E39 Klett-Bårdshaug was focus. As described earlier, there was no possibility of finding the data needed for a comparison of construction costs. However, reliable and valid data was found at the maintenance part regarding standardised contract for the NPRA, and the project made conceptual estimate for the maintenance cost for the project over the whole operation period. The cost, which is found to be just below 350 million NOK (2013 value) show an estimate if the road costs with NPRA maintenance standards. From the paragraph above, it is clear that the improvements the PPP company did, should make the maintenance budget lower. As the analysis show, they had focus on the most cost consuming budget posts, by for example trying to optimize the electricity costs and pavement costs. When constructing the bridge, the PPP company also used a standardized wagon, which somehow has helped reducing the total LCC through saving costs for hire of multiple wagons.

The conceptual estimate also revealed that the correlation between the traffic of the different sectors of the road and the expenses for maintenance had high correlation. In the contract, only the traffic of the last three sectors was used as calculation for traffic forecast, even though the cost estimate revealed that the contribution the maintenance costs was relatively evenly distributed over all four stretches. In future, the calculations in this thesis show that the costs can be weighted with traffic volumes for the different road sectors.

The calculations also confirm normal the higher maintenance costs for tunnels. This is of course natural, as all figures used are general numbers based on experience in existing projects. In this project, the tunnels stand for 40 % of the road length and 55 % of the expenses. The same can be said about bridges, even though the variation for bridge maintenance costs are high, and total length is relatively short for the total road parcel. They neither are affected by traffic volume in the calculations. Standing for 3 % of the road length, they contribute to 14 % of the total maintenance costs, 4,5 times higher than length.

6.4 FURTHER WORK

As the PPP projects go on, and enter their final phase, and eventually the transferral of the road into the ownership of the NPRA, it will be interesting, and necessary to take a new and more thorough look at the results and status of the road and the project. As the contract goes on, it will be interesting to see if the companies experience more positive effects of the measures taken with respect to quality. With the new government, the possibility of new PPP projects has increased. If new projects emerge, it would be interesting to see how they are organised compared to the existing ones. If they continue with the same financing, and if the bidding process is made shorter and less resource consuming.

6.4.1 Financial comparison

In this project, there has been hard to obtain factual construction costs. It proved so hard it is not part of the project because of business matters and lack of updated data from the NPRA. However, the digital database where the NPRA are storing costs is useful in the matters, because very detailed information of all parts of new road construction projects will be obtainable from that as reference in future comparisons. At the time, the roads that can compare itself to the E39 Klett-Bårdshaug is either too old to be reported in the database, or there are not reported data for similar sectors. In this project, the only available data was a reference sector in a total different geographical area. The road standard followed for this sector was also of another quality than the PPP Klett-Bårdshaug.

This implies that the foundation for a good comparison of data is present if the utilization of the Cost Database is used as reference in the future, and can with combination of the maintenance cost report perform a cost analysis like the one who is performed for maintenance only in this project.

6.4.2 Results from the road development contract compared to PPP

With the NPRA's making of the road development contract, it will be a natural continuation of this thesis to do a comparative analysis of this project compared with the PPP projects, where some of the ideas are gathered. Looking at the construction time, and what measures were taken in the construction to reduce maintenance costs will give a clear picture of what measures actually have an influence on the construction time, and on the quality. A general view when the project has been finished for a few years will be enough to get a general look, but a deeper study with the standard costs will give an even better view.

6.4.3 Work for the NPRA

The NPRA should use the cost estimates developed for the maintenance of the PPP project, and compare this estimate to the factual numbers. These numbers should also be seen in comparison to similar projects, which were one of the intentions of this project. As mentioned earlier, with the new focus on PPP, the NPRA should also look at what elements they would like to keep, and which to change for future PPP projects.

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